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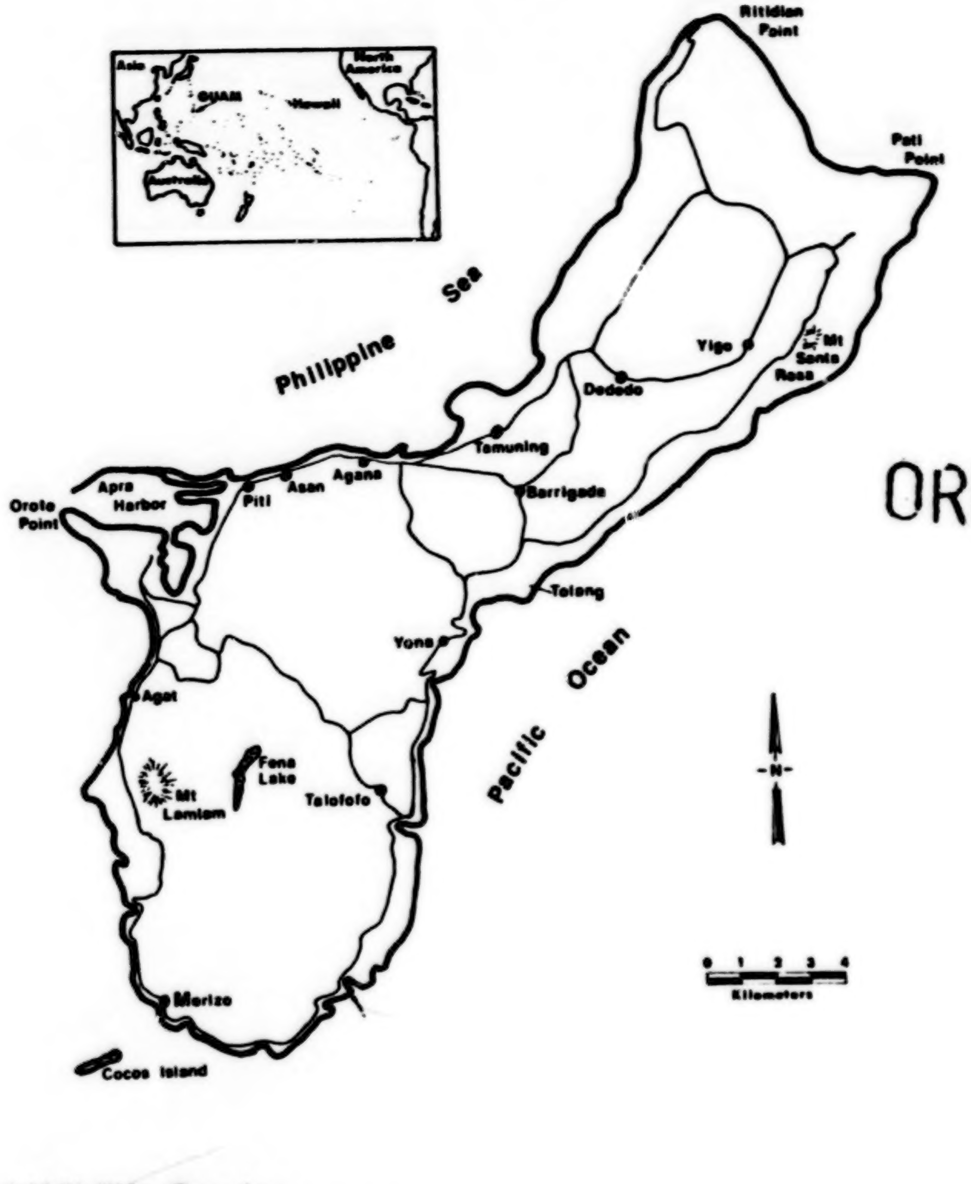
Distribution and Abundance of the Forest Birds of Guam: Results of a 1981 Survey



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Fish and Wildlife Service

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FWS/OBS 84/20
September 1984

DISTRIBUTION AND ABUNDANCE OF THE FOREST BIRDS OF GUAM: RESULTS OF A 1981 SURVEY

by

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in cooperation with
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Agana, Guam

Performed for
National Coastal Ecosystems Team
Division of Biological Services
Research and Development
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U.S. Department of the Interior
Washington, DC 20240

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DISCLAIMER

The findings in this report are not to be construed as an official U.S. Fish and Wildlife Service position unless so designated by other authorized documents.

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PREFACE

Information on the status and distribution of the native forest birds of Guam has been generally sparse or unavailable. Moreover, most of the information available was collected immediately after World War II (1945-46) or pre-dates this period. The cooperative avifauna surveys conducted by the Division of Aquatic and Wildlife Resources, Territory of Guam, and the U.S. Fish and Wildlife Service represent the first comprehensive systematic effort for obtaining current baseline data on the status and distribution of Guam's avifauna.

The general decline of Guam native forest birds over the past 20 years, and the rather advanced state of decline in bird distribution, densities and population sizes in 1981 was documented by the surveys. Guam birds have continued to decline precipitously since the 1981 surveys, and the status of all species is much more critical than the 1981 results indicate. The cause of this decline is uncertain, but studies are continuing to ascertain whether predation by an introduced snake and/or whether avian disease is causing this decline.

The surveys are providing base line information necessary for assessing endangered status of Guam's native forest birds. Information generated from the 1981 surveys and those conducted subsequently by staff of the Division of Aquatic and Wildlife Resources have provided information for developing listing proposals for several species. In addition, they have identified the key remaining habitats for Guam's native birds.

The results of the surveys have attracted attention to the plight of Guam's native forest birds and other insular avifauna of the Pacific Basin. They have also suggested a means for monitoring avian populations on other Pacific Islands in order to detect declines at an early stage so that positive conservation actions might be implemented to arrest or reverse those declines.

Any suggestions or questions regarding this report should be directed to:

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CONTENTS

Page

PREFACE iii
FIGURES vi
TABLES vii
ACKNOWLEDGMENTS ix
CONVERSION TABLE x

INTRODUCTION 1
SETTING 2
AVIFAUNA 4
METHODS 6
  Study Area 6
  Variable Circular Plot Method 6
  Special Survey Methods 10
  Habitat Classification 11
  Determination of Available Habitat 15
RESULTS 15
  Summary 15
  Species Accounts 15
    Native Forest Birds 15
      Bridled White-eye 15
      Cardinal Honeyeater 18
      Guam Broadbill 22
      Guam Rail 22
      Mariana Crow 27
      Mariana Fruit-Dove 31
      Micronesian Kingfisher 33
      Micronesian Starling 33
      Rufous-fronted Fantail 36
      Vanikoro Swiftlet 36
      White-throated Ground-Dove 36
    Nonforest and Introduced Birds 38
    Seabird and Waterbirds 38
      Common Moorhen 38
      Brown Noddy 38
      Pacific Reef Heron 40
      White Tern 40
      Yellow Bittern 40
    Introduced Birds 41
      Black Drongo 41
      Black Francolin 42
      Blue-breasted Quail 42
      Chestnut Mannikin 42

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CONTENTS (Cont'd.)

Page

Eurasian Tree Sparrow 44
Philippine Turtle-Dove 44
Red Junglefowl 44

DISCUSSION 44
RECOMMENDATIONS 51

LITERATURE CITED 52

FIGURES

Number Page

1 Map of Guam and its relative position in the Pacific 3

2 Bird survey stations and regional boundaries of northern Guam 7

3 Location of bird survey stations on southern Guam 8

4 Approximate 1981 distribution of the Guam Rail, based on surveys by the GAWRD 25

TABLES

Number		Page
1	Resident birds of Guam	5
2	Location and number of bird survey stations and number of completed 8-min counts	9
3	Regions of northern Guam and Cocos Island with areas of each habitat type	14
4	Habitat types presently utilized (available habitat) by eleven native forest birds and two introduced species on Guam	16
5	Species and number recorded during survey	17
6	Forest bird population size estimates for each region	19
7	Confidence limits (95%) for total population size estimates	20
8	Bridled White-eye species summary	21
9	Cardinal Honeyeater species summary	23
10	Guam Broadbill species summary	24
11	Occurrence of Guam Rail based on 8-min counts during this survey, GAWRD 15-min counts, and playback recordings	26
12	Guam Rail species summary	28
13	Density of Mariana Crow in three regions of northern Guam as determined by total counts	29
14	Mariana Crow species summary	30
15	Number of Mariana Crows recorded from 1978-1981, GAWRD 8-min counts, station numbers 3-15	31
16	Mariana Fruit-Dove species summary	32

TABLES (Continued)

Number		Page
17	Micronesian Kingfisher species summary	34
18	Micronesian Starling species summary	35
19	Rufous-fronted Fantail species summary	37
20	White-throated Ground-Dove species summary	39
21	Yellow Bitterns recorded during 8-min counts	41
22	Black Drongo species summary	43
23	Philippine Turtle-Dove species summary	45
24	Behavioral patterns influencing the ability of the variable circular plot method to estimate absolute population density	47
25	Changes in distribution of Guam forest birds through history	49

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Part of the support for this study was provided by Federal Aid in Wildlife Restoration Act funds granted to the Guam Aquatic and Wildlife Resources Division.

CONVERSION FACTORS

Metric to U.S. Customary

Multiply	By	To Obtain
millimeters (mm)	0.03937	inches
centimeters (cm)	0.3937	inches
meters (m)	3.281	feet
kilometers (km)	0.6214	miles
square meters (m^2)	10.76	square feet
square kilometers (km^2)	0.3861	square miles
hectares (ha)	2.471	acres
liters (l)	0.2642	gallons
cubic meters (m^3)	35.31	cubic feet
cubic meters	0.0008110	acre-feet
milligrams (mg)	0.00003527	ounces
grams (g)	0.03527	ounces
kilograms (kg)	2.205	pounds
metric tons (t)	2205.0	pounds
metric tons	1.102	short tons
kilocalories (kcal)	3.968	British thermal units
Celsius degrees	1.8(C°) + 32	Fahrenheit degrees

U.S. Customary to Metric

Multiply	By	To Obtain
inches	25.40	millimeters
inches	2.54	centimeters
feet (ft)	0.3048	meters
fathoms	1.829	meters
miles (mi)	1.609	kilometers
nautical miles (nmi)	1.852	kilometers
square feet (ft^2)	0.0929	square meters
acres	0.4047	hectares
square miles (mi^2)	2.590	square kilometers
gallons (gal)	3.785	liters
cubic feet (ft^3)	0.02831	cubic meters
acre-feet	1233.0	cubic meters
ounces (oz)	28.35	grams
pounds (lb)	0.4536	kilograms
short tons (ton)	0.9072	metric tons
British thermal units (Btu)	0.2520	kilocalories
Fahrenheit degrees	0.5556(F° - 32)	Celsius degrees

INTRODUCTION

The birds of Guam are among the least known of America's avifauna, and only recently has attention been directed toward this Western Pacific island. There have been three general periods of research on the island: expeditions before and around the turn of the century which concentrated on collecting and describing specimens; observations and collections by servicemen during and immediately after World War II (Baker 1951); and survey, life history, and ecology studies recently conducted by visiting ornithologists and the Guam Aquatic and Wildlife Resources Division (GAWRD) (Jenkins 1983). Ten to twenty years ago a dramatic decline of native land birds was noted. So rapid and extensive was this disappearance that vast areas of forest are now devoid of all bird life (Pratt et al. 1979; Ralph and Sakai 1979; Jenkins 1983), and 12 species have been proposed as candidate threatened or endangered species (USFWS 1979, 1983; Jenkins and Aguon 1981). In response to this precipitous decline, the U.S. Fish and Wildlife Service and the GAWRD conducted a survey of the forest birds of Guam in June 1981. This paper reports the results of that survey.

SETTING

The U.S. Territory of Guam is located at 13° 30' N. latitude and 145° E. longitude, and is nearly equidistant from Japan to the north, the Philippines to the west, and New Guinea to the south (Figure 1). Geographically it is a part of Micronesia, a vast expanse of ocean and islands which includes the Marshall, Caroline, Gilbert, and Mariana Island groups. Guam, the southernmost island of the Mariana Archipelago, is the largest and most developed of all islands in Micronesia and constitutes the defacto capital for this region of the Pacific. Several large Naval and Air Force installations have been constructed and maintained on Guam since the end of World War II, and it is this status as a military outpost for which it is perhaps best known.

Of all Micronesian islands, Guam has had the longest and most extensive contact with the outside world. The Spanish maintained Guam as a colony for nearly 300 years, until the island was ceded to the United States after the Spanish-American War in 1898. Since then, it has remained a territory of the United States except for a brief period of Japanese occupation during World War II. The Chamorros are the original inhabitants of the island and are thought to have settled on Guam about 4,000 years ago. They were decimated by disease and wars during the Spanish era and today no full-blooded Chamorros survive. The local residents are now a mixture of Chamorro, Spanish, Filipino, Mexican, and many other nationalities. About half of the present day population of 100,000 is local, and the other half is constantly changing military and government personnel from outside of Guam. Carano and Sanchez (1964) presented a complete history of Guam.

Guam is 49 km long and 7-15 km wide, and has an area of 550 km² (U.S. Army Forces Far East 1959). A fringing reef encircles the entire island except at small areas along limestone cliffs. A narrow, central waist separates the island into a northern, fairly level, limestone plateau, and a southern, more mountainous region of volcanic origin.

The northern limestone plateau, which averages 100-200 m above sea level, is rimmed by cliffs that drop precipitously to a narrow bench, and thence to the ocean. The bench is generally 100-300 m wide, but at Tarague Basin it extends up to 900 m. The highest point on the plateau is Mount Santa Rosa (260 m), a gently rising mountain of volcanic origin. Two other prominent hills rise above the plateau, Mataguac Hill (180 m) and Barrigada Hill (200 m). No permanent streams, ponds, or marshes occur on the northern plateau because of the porous limestone.

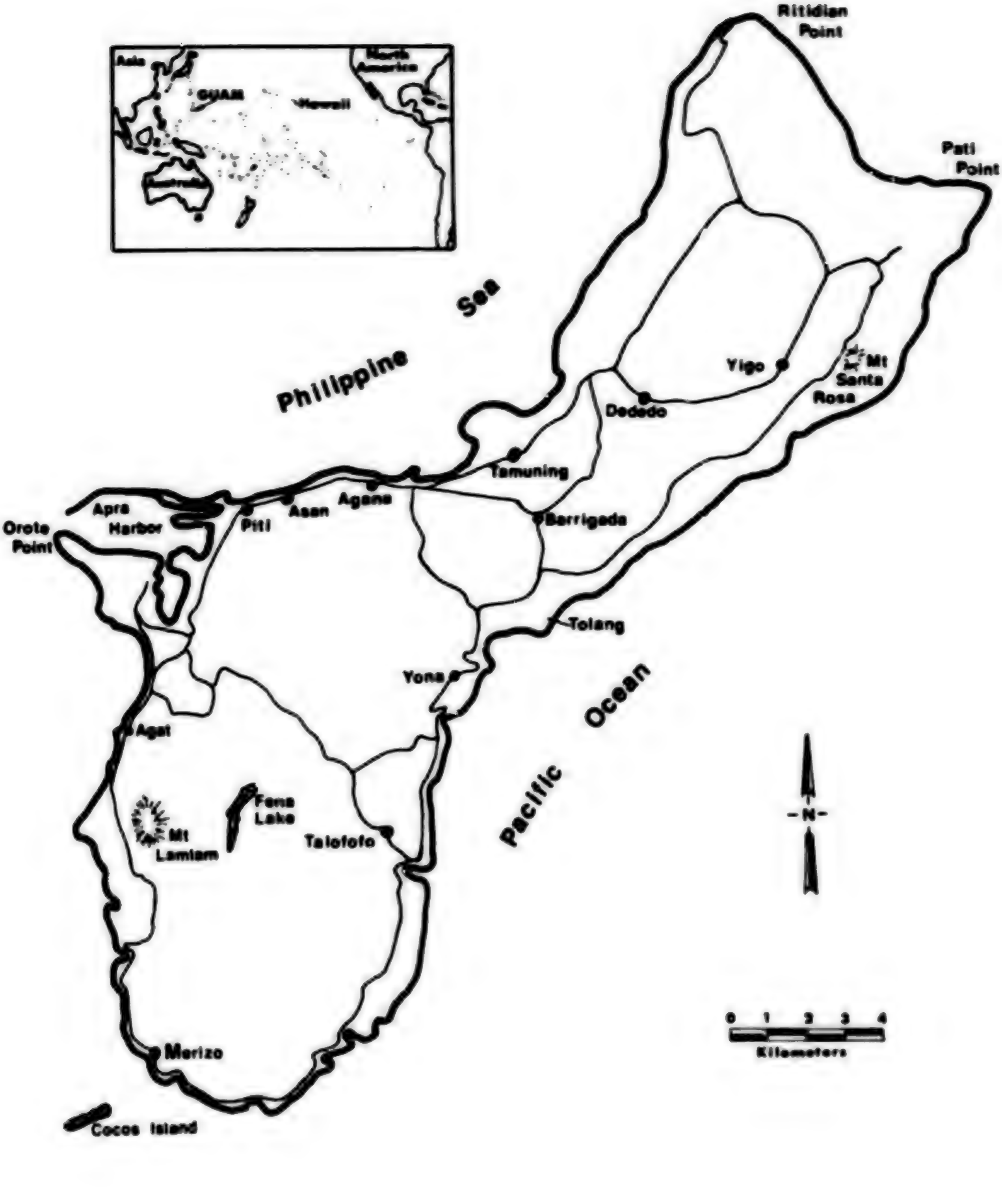

Figure 1. Map of Guam and its relative position in the Pacific.

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The southern, volcanic portion of the island is rugged, and is characterized by mountains, rolling hills, and stream valleys. The soil is typically a reddish, weathered clay. Mount Lamlam (405 m) in the Southwest is the highest point on the island. There are numerous streams on the nonpermeable, volcanic soil of southern Guam; the two largest bodies of standing water are Fena Reservoir and Agana Swamp.

Over the past several thousand years of human influence, the vegetation of Guam has become among the most altered of all Micronesian islands, and the original floral composition is difficult to reconstruct (Fosberg 1960). At one time a tropical forest covered all or most of the island, but today it is greatly dissected by savannas, open fields, urban areas, military installations, and roads. Typically, the northern portion of Guam supports a diverse forest, while the southern portion harbors savannas on the exposed uplands and forest in the more sheltered valleys. The extensive savannas on the uplands of southern Guam are thought to be the result of aboriginal clearing and subsequent burning which has continued through the centuries to today (Fosberg 1960; Mueller-Dombois 1981).

The climate of Guam is warm and humid; the mean monthly temperature is about 27° C with only slight variation from month to month. Daytime temperatures are usually 29°-32° C, and drop to 24°-27° C at night. Annual rainfall is about 250 cm of which three-fourths falls during the wet season, July through November. During this time winds may blow from any direction but are generally light. The dry season extends from January through May, when steady tradewinds blow from easterly directions. December and June are transitional wind and rainfall months. Typhoons regularly pass over Guam, generally during the wet season. (Climatic information from U.S. Army Forces Far East 1959.)

AVIFAUNA

Owen (1977) listed 72 species of Guam birds; however, since his 1977 checklist there have been at least ten new records for the island (Jenkins 1978; Maben and Wiles 1981). The majority of these birds are migrant or vagrant species, and the resident avifauna comprises only 24 species (Table 1), of which 17 are native and 7 are introduced (Owen 1977). Of the 17 native species, 11 are forest birds, 3 are seabirds, and the remaining are a gallinule (moorhen), a bittern, and a heron. In this report we confine ourselves primarily to the 11 native forest birds though brief accounts are also given for introduced species. Scientific and common names follow Owen (1977) and Pratt et al. (1979). In this report we have arranged species accounts alphabetically by common name.

A comprehensive account of the life histories, behavior, and ecology of native Guam forest birds, as well as a review of earlier literature, is given by Jenkins (1979, 1983), who conducted field studies from January 1978 to December 1979. Most forest birds of Guam are generalists and exhibit few of the specialized adaptations that have evolved in other insular communities

Table 1. Resident birds of Guam. N = Native; I = Introduced.

Common name	Scientific name	
Black Drongo	*Dicrurus macrocercus*	I
Black Francolin	*Francolinus francolinus*	I
Blue-breasted Quail	*Coturnix chinensis*	I
Bridled White-eye	*Zosterops conspicillata*	N
Brown Noddy	*Anous stolidus*	N
Cardinal Honeyeater	*Myzomela cardinalis*	N
Chestnut Mannikin	*Lonchura malacca*	I
Common Moorhen	*Gallinula chloropus*	N
Eurasian Tree Sparrow	*Passer montanus*	I
Guam Broadbill	*Myiagra freycineti*	N
Guam Rail	*Rallus owstoni*	N
Mariana Crow	*Corvus kubaryi*	N
Mariana Fruit-Dove	*Ptilinopus roseicapilla*	N
Micronesian Kingfisher	*Halcyon cinnamomina*	N
Micronesian Starling	*Aplonis opaca*	N
Pacific Reef Heron	*Egretta sacra*	N
Philippine Turtle-Dove	*Streptopelia bitorquata*	I
Red Junglefowl	*Gallus gallus*	I
Rufous-fronted Fantail	*Rhipidura rufifrons*	N
Vanikoro Swiftlet	*Aerodramus vanikorensis*	N
White-tailed Tropicbird	*Phaethon lepturus*	N
White Tern	*Gygis alba*	N
White-throated Ground-Dove	*Gallicolumba xanthonura*	N
Yellow Bittern	*Ixobrychus sinensis*	N

such as Hawaii or the Galapagos. Historically, and until the early 1960's, all resident species of forest birds were relatively common throughout the forests of Guam (Baker 1947; Jenkins 1983). Within the last 20 years, forest birds have suffered a tremendous decline in numbers and range, and today, viable populations exist only on the northern half of Guam. Five species of indigenous Guam birds, the Micronesian Megapode (*Megapodius laperouse*), Mariana Mallard (*Anas oustaleti*), White-browed Rail (*Poliolimnas cinereus*), Wedge-tailed Shearwater (*Puffinus pacificus*), and Nightingale Reed-warbler (*Acrocephalus luscinia*), have become extinct since the island was discovered by Europeans. Except for the reed-warbler, these species became extinct well before the decline of forest birds began. It is believed that loss of habitat and excessive hunting were major reasons for these extinctions. The cause of these extinctions appears to be unrelated to the as yet unidentified cause or causes for the present decline of forest birds.

METHODS

STUDY AREA

With few exceptions, most forest birds now reside only on northern Guam (Jenkins 1983), and our survey was confined primarily to this area. To better identify bird species distribution and areas of primary value to forest birds, northern Guam was divided into 15 regions (Figure 2). Boundaries for the 15 regions were based on manmade or natural borders, such as roads, cliffs, or habitat edges. Cocos Island, a small low island just south of Guam that supports a remnant Micronesian Starling population, was also surveyed and considered a separate region. A few of the more forested areas in southern Guam were also sampled (Figure 3), mainly to confirm the absence of native birds in the South. No distinct regions were demarcated as on northern Guam.

VARIABLE CIRCULAR PLOT METHOD

The variable circular plot method (Reynolds et al. 1980) was used in the survey; it was designed to determine density in structurally complex vegetation types with rugged terrain. The method consists of marking stations (points) in the survey area and conducting counts at each station. During each count, all birds heard or seen and their lateral distance from the observer are recorded. The data are analyzed by determining an effective detection distance (or area) for each species which is then used to calculate densities (Ramsey and Scott 1981). The effective detection area is a species-specific area determined by examining the cumulative detection distances for each species. Several methods may be used to determine effective detection areas (Ramsey and Scott 1981). Population sizes are determined by multiplying available forest habitat (Tables 3 and 4) by bird densities. The effective area surveyed (see species summary tables) is the total area actually surveyed for each species and is based upon the effective detection area.

In determining placement of stations, we used a stratified sampling technique which concentrated effort in regions with the highest expected densities. Approximate expected densities were needed to utilize this approach, and these were available from recent GAWRD counts (Maben and Aguon 1980). The number of survey stations chosen provided a high probability of encountering a total of at least 30 individuals of rare species (Thompson 1982). We avoided the sheer cliffs of northern Guam, and in general, no stations were placed within 100 m of a coastline. All stations on transects or along trails were 150 m apart, except for the eight stations in the Talofofo Watershed and the nine stations in the Central Plateau, which were widely scattered. Large open fields, beach scrub, and urban areas were excluded from the survey.

We established 214 stations: 178 in northern Guam and 36 in southern Guam (Table 2 and Figures 2 and 3). Of the 214 stations, 113 were randomly located, 97 were placed along foot or jeep trails in forest habitat, and four were located along the Fena Lake shoreline. The bias inherent in placing stations

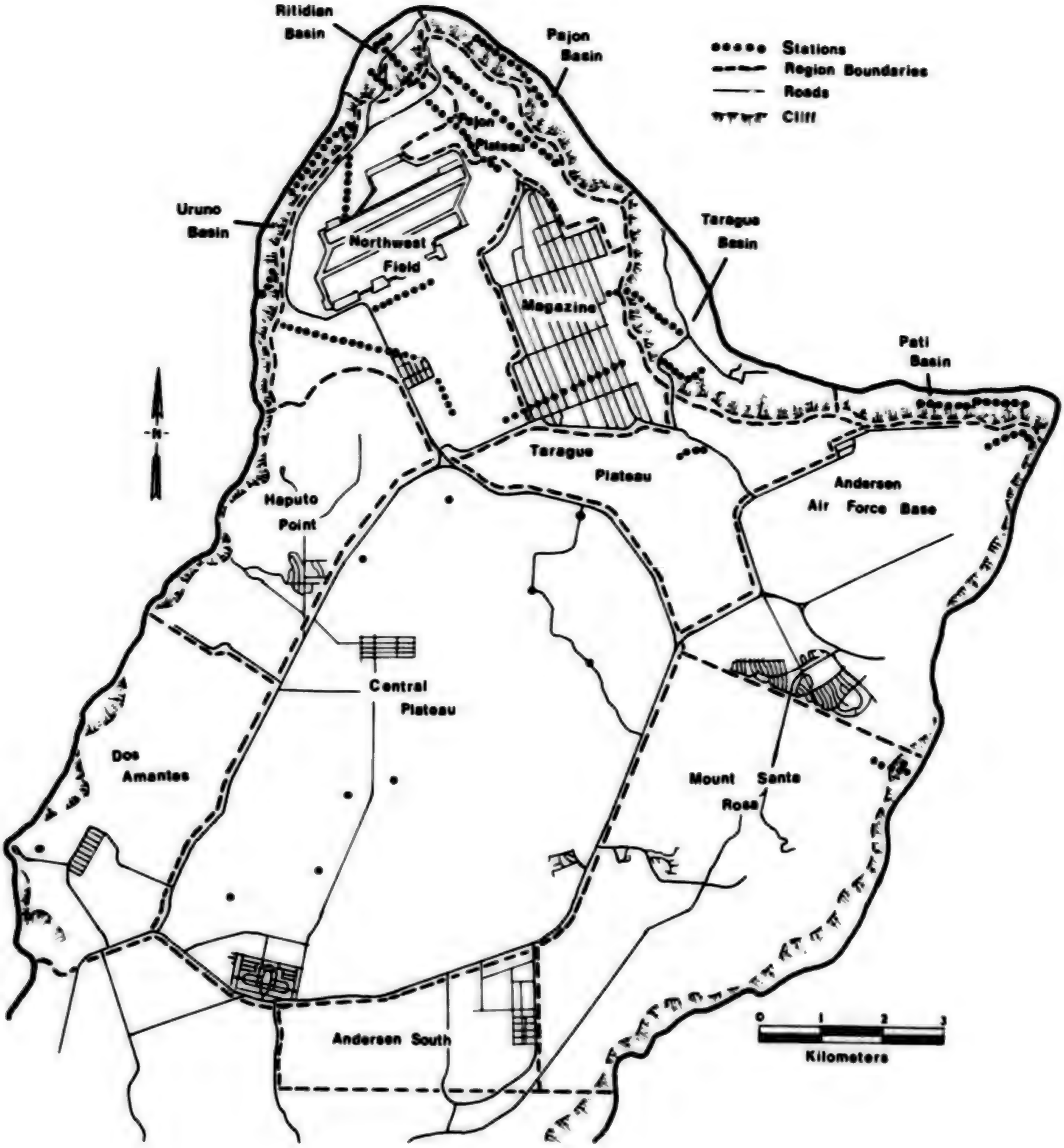

Figure 2. Bird survey stations and regional boundaries of northern Guam. Region areas are given in Table 2.

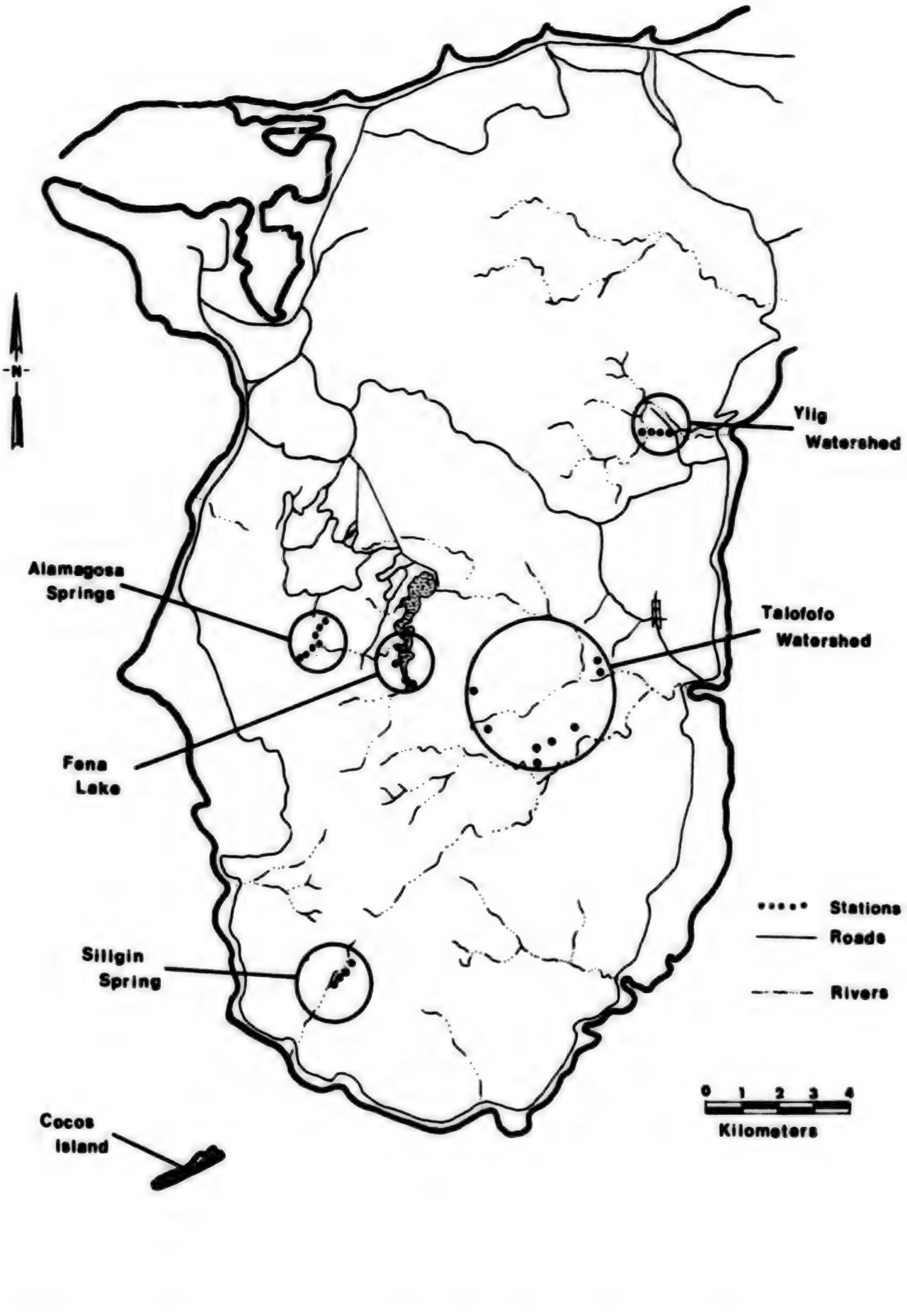

Figure 3. Location of bird survey stations on southern Guam.

Table 2. Location and number of bird survey stations and number of completed 8-min counts.

Regions	Number of stations	Randomly selected stations	Stations along trails	Number of 8-min counts
Northern Guam				
Pati Basin	12	12		29
Andersen AFB	6		6	12
Tarague Basin	17	5	12	50
Tarague Plateau	4		4	8
Magazine	14	12	2	30
Pajon Basin	12	12		24
Pajon Plateau	22	16	6	42
Ritidian Basin	12	12		29
Northwest Field	48	19	29	93
Uruno Basin	15	15		30
Haputo Point[a]	0			0
Central Plateau	9		9	19
Mt. Santa Rosa	6		6	14
Dos Amantes	1	1		3
Andersen South[a]	0	0		0
Southern Guam				
Cocos Island	9	9		24
Alamagosa Spring	7		7	7
Fena Lake	4		4	4
Siligan Spring	4		4	4

(continued)

Table 2. (Concluded).

Regions	Number of stations	Randomly selected stations	Stations along trails	Number of 8-min counts
Southern Guam (continued)				
Talofofo Watershed	8		8	8
Ylig Watershed	4		4	4
Total	214	113	101	434

[a] No counts were made in these two regions, and distribution and density information is taken from 1981 counts by the GAWRD.

along trails should be noted; namely, the possible influence of trails on the distributions of certain species. This bias is thought to be minimal in this study; the trails chosen were rarely if ever traveled, disturbance of the canopy and understory was negligible on foot trails, and the "unlimited distance" point counts insured that birds well off the trail were surveyed.

Transects and stations were marked with colored flagging, and each station was identified with a numbered aluminum tag. In most instances, for safety and comparative purposes, simultaneous counts by two observers were made at each station. Observers were separated by 20 m, and counts lasted 8 minutes (8-min counts). Counts began at sunrise and continued to 1000 hours, a period of about 4 hours (11 counts began between 1000 and 1100 hours). Counts were only made under favorable weather conditions (i.e., no rain, and wind under 4 on the Beaufort scale). We chose to survey in June, when rain and winds are relatively light.

Five biologists collected the field data. Before beginning the survey, observers practiced field identification of birds and distance estimation, following a training program described by Kepler and Scott (1981). Compared to many areas, Guam has a relatively simple avifaunal community; the observer is concerned with only about a dozen forest birds, and all have relatively distinct calls and field marks.

Distances were estimated to birds up to 300 m from the observer. Birds that were thought to be beyond this distance were simply recorded as being 300 m from the observer.

SPECIAL SURVEY METHODS

Special survey methods were used for the Guam Rail and Mariana Crow. The rail is a very secretive species, and we tested the feasibility of using taped calls to stimulate a response. The GAWRD has recently been using playback recordings of the call to study territory size, and the technique has been successful in sampling populations of other avian species, particularly other Rallidae (Falls 1981; Johnson et al. 1981; Marion et al. 1981).

A "count" consisted of playing at full volume a taped call of the rail on a cassette player, then waiting quietly 1-2 minutes for a response. The taped call, actually a chorus of several individuals, lasted 45 seconds. If a rail began to respond while the tape was playing, the tape was stopped to better identify the number and distance of the individual or individuals calling. Counts with taped recordings were made from 0600-1100 hours, and were conducted separately from the standard 8-min counts.

The Mariana Crow has a call that carries great distances. Because we made no distance estimates to birds over 300 m from the observer, the standard program used for calculating densities was not used for the crow. Instead, total counts were made in three regions and compared with data from the standard 8-min counts. A conversion factor was then determined that could be applied to 8-min counts from other regions. Densities were determined by direct count in Tarague, Ritidian, and Uruno Basins, three regions along the coastal bench. These basins form ideal survey units, as the cliffs act as natural sound amplifiers and allow an unobstructed view of each region. Under proper weather conditions, any crow calling from within the basin can be readily heard. At Uruno Basin, the survey area extended slightly beyond the cliff edge onto the upper plateau. On 24 June, an observer was placed at an overlook above each region, and for a period of 1.5 - 2 hours (0600-0800), all crows heard or seen and their movements were recorded. Tape-recorded calls of the crow were played at the end of the count period at Ritidian and Tarague basins to ascertain if any uncounted individuals remained in the survey region.

HABITAT CLASSIFICATION

To determine the amount of habitat available for each bird species it was first necessary to map the vegetation. Eight general habitat types were defined and mapped for the 15 regions of northern Guam and one region of Cocos Island. Habitat types were mapped directly on 1:25,000 scale aerial photographs, and areas were measured with a digital planimeter. Areas for each habitat type in each of the 16 regions are given in Table 3. The eight habitat types were defined as follows:

1. Primary Limestone Forest: This is forest of a diverse nature with a moderately dense canopy 10-30 m high. There are no or only a few openings, and understory vegetation varies from open to dense. Fosberg (1960) and Stone (1970) described this habitat as "forests of elevated hard limestone." Much of the uninhabited area of far northern Guam, as well as the cliff and bench areas along the coast, is of this type.

   The tallest and best developed primary limestone forests, classified as mature limestone forests by Jenkins (1983), are found on the sheltered and relatively inaccessible coastal benches. Pajon and Uruno Basins support fine examples of nearly climax forest, with a high, closed canopy and an open understory. Massive specimens of Pisonia (pisonia) and Ficus (banyan) can be found here. On the exposed upper plateau, the limestone forest is characteristically more scrubby. Typhoons, which regularly pass through Guam, are thought to prevent this forest from reaching a climax state (Stone 1970). Disturbance by humans is common on the plateau. Along the eastern, windward coast, limestone forests are also poorly developed; forests of Pati Basin and Andersen AFB are typical examples. In these regions, the understory is generally dense, but at Pati Basin, the forested terrace halfway up the cliff has an open understory. This may be, in part, the result of browsing and trampling by sambardeer (Cervus unicolor).

2. Broken Forest: Although similar to limestone forest, this "mixed woodland" (Jenkins 1983) is much dissected by many small, open or scrubby fields, which make up 10%-25% of the area. Broken forest is the result of human disturbance, and is confined mostly to the Central Plateau and Mt. Santa Rosa regions. The Magazine, a level region of limestone forest that is traversed by a series of parallel roads, is also considered broken forest. The roads are separated by about 150 m, and numerous openings, each about 50 m^2, are found at regular intervals along the roads.

   Cocos Island is classified as broken forest. Most of the island is covered by a mixed forest (Neubauer and Neubauer 1981) but there are two conspicuous openings, one the result of an abandoned U.S. Coast Guard Station and the other a new resort development.

3. Coconut Forest: Stands from abandoned Cocos (coconut) plantations constitute this forest type. The canopy, 15-25 m high, is moderately dense and generally complete. In most areas there is a thick understory composed of a variety of shrubs and young trees including numerous young Cocos. Extensive Cocos stands are found only along the sandy coastal benches such as Tarague, Ritidian, Pajon, and Uruno Basins. Though small patches of Cocos are common throughout the northern half of Guam, most are small (under 5 ha) and relatively diverse, and therefore are excluded from this habitat type.

4. Scrub Forest: This diverse, brushy forest generally has an open canopy under 10 m high with a dense understory. It is described by Jenkins (1983) as "second growth" or "scrub vegetation." The plant species are generally similar to those in more mature limestone forests, but are at an earlier stage of development. One exception is Leucaena (tangantangan), which occurs in pure stands in scrub forests, but is not shade tolerant and thus is not generally found in mature forests.

   Much of the Tarague Plateau and Northwest Field Region is scrub forest. On Tarague Plateau, past forest clearing by the military and typhoons are probably the major reasons for the scrubby nature of the region. Large dead trees that extend above the scrubby canopy can be found throughout the area, though the exact reason for their demise is uncertain (Fosberg 1960). The Northwest Field Region was at one time an extensive air base, but it has since been cleared of dwellings and structures and is returning to a forest condition. Pure, dense stands of Leucaena are common along the old runways, as in many disturbed areas of Guam. In old residential areas are a variety of introduced ornamental shrubs and trees.

Scrub forest is also common along the windward coast. In Pati Basin, small patches of scrub forest, composed nearly exclusively of Hibiscus (hibiscus tree), are common on the lower coastal bench. In the Andersen AFB and Mt. Santa Rosa Regions, most of the forest from the top of the cliffs to the coastline is windblown and short and is classed as scrub forest.

5. Beach Scrub: Open sand beaches, barren coastal outcroppings, and coastal areas of sparse vegetation generally 2-3 m or shorter in height comprise this habitat. The dominant plant is Pemphis (pemphis), a salt-tolerant species common on the pitted limestone of the windward coasts. Scrubby stands of Pemphis are most extensive in the Pati Basin, Andersen AFB, and Mt. Santa Rosa regions. A small strip can also be found along the exposed southeast coast of Cocos Island. The beach scrub of Tarague, Pajon, Ritidian, and Uruno Basins consists primarily of sand beaches.

6. Open Field: This habitat type includes agricultural fields, and other open areas that are removed from urban or residential areas (most fields are near residential and urban regions, and are included in the "Agriforest" and "Urban" habitat types). Examples include an extensive, but now unused cattle pasture in the Dos Amantes Region and communication stations in the Haputo Region where the grass is mowed. Open field habitat is the result of human disturbance.

7. Agriforest: This is a highly dissected mosaic of dwellings, open fields, gardens, scrub forest, limstone forest, and old Cocos groves. Common in agriforest are numerous small holdings that are used for subsistence farming and known locally as "ranches". Much of the central portion of northern Guam consists of this habitat, especially the Central Plateau Region.

8. Urban: Urban and residential areas, adjacent fields and openings, and runways comprise this habitat. Most of the Andersen AFB Region is urban, as are several towns (Dededo and Yigo) in more southerly regions. The Northwest Field Region has numerous abandoned runways which are classed as urban; a typical scrub forest surrounds these runways.

Table 3. Regions of northern Guam and Cocos Island with areas (km^2) of each habitat type.

Region	Primary limestone forest	Broken forest	Scrub forest	Coconut forest	Beach scrub	Open field	Agriforest	Urban	Total
Pati Basin	1.18		0.36		0.25				1.79
Andersen AFB	2.66		1.98		0.21			12.85	17.70
Tarague Basin	2.23			1.98	0.23	0.10			4.54
Tarague Plateau	3.97	0.13	6.20					0.22	10.52
Magazine	1.54	5.09							6.63
Pajon Basin	1.47			0.24	0.19				1.90
Pajon Plateau	3.78								3.78
Ritidian Basin	0.91			0.19	0.08	0.12			1.30
Northwest Field	7.07		8.15					1.05	16.27
Uruno Basin	1.84			0.17	0.08				2.09
Haputo Point	3.05	1.78	2.30			2.51		1.20	10.84
Central Plateau		21.59	0.08				16.39	5.53	43.59
Mt. Santa Rosa	5.93	7.06	2.91		0.33	1.87	4.58	1.46	24.14
Dos Amantes	2.23	1.93	1.76			2.65	2.65	1.28	12.50
Andersen South		0.47	2.42				3.75	0.63	7.27
Cocos Island		0.27			0.10				0.37
Total	37.86	38.32	26.16	2.58	1.47	7.25	27.37	24.22	165.23

DETERMININATION OF AVAILABLE HABITAT

To calculate bird population sizes it was first necessary to know the type and amount of habitat utilized by each species. Nearly all forested habitats are used by all forest birds (Jenkins 1983). As a general rule, primary limestone forest, broken forest, scrub forest, and coconut forest are utilized by forest birds, while open field, beach scrub, and urban habitat are not (Table 4). Agriforest and urban habitats are utilized to a limited extent by several species (Table 4). Historically, several other species could be found in agriforest or even urban areas, but they have now disappeared from these habitat types (Jenkins 1983; Maben, pers. comm.). Because the Bridled White-eye, Mariana Fruit-Dove, and White-throated Ground-Dove rarely frequent coconut forest, this habitat type was not considered available to these species.

RESULTS

SUMMARY

A total of 435 8-min counts were made at the 214 stations, and 5,399 individuals of 23 species were recorded (Table 5). The only resident species that was not recorded during 8-min counts was the White-tailed Tropicbird. The most often recorded species was the Micronesian Starling (1,787), followed by the Mariana Crow (869), Black Drongo (503), and Micronesian Kingfisher (484). Among the most seldom recorded species were the feral Red Junglefowl (1), Common Moorhen (2), Guam Rail (3), Blue-breasted Quail (3), and Brown Noddy (7). The majority of birds recorded (70%) were native forest birds.

SPECIES ACCOUNTS

Native Forest Birds

The present survey corroborates recent reports of a much restricted range for all native forest species. We estimated regional and total population size for nine of the forest birds (Table 6). The 95% confidence limits for total population estimates are given in Table 7. In nearly all cases the presence or absence of a species within each region could be determined from information derived from 8-min counts, but in a few instances, incidental observations or recent information from GAWRD surveys were utilized.

Bridled White-eye, Zosterops c. conspicillatus. The species is found in the Caroline and the Mariana Islands. The subspecies is endemic to Guam.

On Guam, the white-eye is inconspicuous and a difficult species to observe. It forms small flocks of three to six birds that move and forage actively in the upper canopy. Low volume contact calls are voiced frequently, particularly when groups are moving from tree to tree.

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Table 4. Habitat types presently utilized (available habitat) by eleven native forest birds and two introduced species on Guam.

Species	Primary limestone forest	Broken forest	Scrub forest	Coconut forest	Beach scrub	Open field	Agriforest	Urban
Bridled White-eye	X	X	X					
Cardinal Honeyeater	X	X	X	X			X	
Guam Broadbill	X	X	X	X				
Guam Rail	X	X	X	X		X	X	
Mariana Crow	X	X	X	X				
Mariana Fruit-Dove	X	X	X					
Micronesian Kingfisher	X	X	X	X			X	
Micronesian Starling	X	X	X	X			X	
Rufous-fronted Fantail	X	X	X	X				
White-throated Ground-Dove	X	X	X					
Vanikoro Swiftlet	X	X	X	X		X	X	
Black Drongo[a]	X	X	X	X		X	X	X
Philippine Turtle-Dove[a]	X	X	X	X		X	X	X

[a] Introduced species.

Table 5. Species and number recorded during survey.

Species	Number heard	Number heard then seen	Number seen	Total
Black Drongo	315	53	135	503
Black Francolin	22	0	0	22
Blue-breasted Quail	3	0	0	3
Bridled White-eye	146	16	2	164
Brown Noddy	4	0	3	7
Cardinal Honeyeater	318	16	14	348
Chestnut Mannikin	38	14	29	81
Common Gallinule	2	0	0	2
Eurasian Tree Sparrow	53	10	15	78
Guam Broadbill	36	5	2	43
Guam Rail	3	0	0	3
Mariana Crow	784	36	49	869
Mariana Fruit-Dove	259	0	0	259
Micronesian Kingfisher	460	15	9	484
Micronesian Starling	1,499	97	191	1,787
Pacific Reef Heron	0	0	10	10
Philippine Turtle-Dove	164	2	66	232
Red Junglefowl	1	0	0	1
Rufous-fronted Fantail	185	7	7	199
Vanikoro Swiftlet	0	1	17	18
White Tern	42	8	142	192

(continued)

Table 5. (Concluded).

Species	Number heard	Number heard then seen	Number seen	Total
White-throated Ground-Dove	50	0	6	56
Yellow Bittern	8	6	24	38
Total	4,392	286	721	5,399

Our population size estimate is 2,220 (Table 8), and the density estimate for Pajon Basin, 1,027/km², is the highest density estimate for any species on this survey. In Pajon Basin, simultaneous counts were made by paired observers over one morning at the 12 established stations, and white-eyes were recorded on every count. In these 24 counts, 107 birds were recorded, an average of 4.5/count. Before the present decline, white-eyes were very likely among the most numerous species on Guam.

The white-eye, though common in certain regions, exhibits a distribution that is more restricted than any other native forest bird. Over 97% of the population resides in less than 2% of the land area on Guam (Table 25). We estimate that the species presently occupies only 2% of its former range. There is evidence that the range for the white-eye has diminished within the last year. Guam Aquatic and Wildlife Resource Personnel recorded the species commonly at Pati Point (Anderson AFB Region) in 1980, but none were found in this vicinity on the present survey.

Cardinal Honeyeater, *Myzomela cardinalis saffordi*. The species is found on numerous islands from American Samoa to the Western Caroline Islands. The subspecies is restricted to the Mariana Islands.

The honeyeater is an active and vocal species, and is relatively conspicuous on northern Guam. It is the only nectarivorous species on Guam, although a significant portion of the diet also consists of animal matter (Jenkins 1983). The honeyeater lends itself well to survey methodology; it is a nonflocking species, it has a medium-volume call that is voiced regularly throughout the morning, and it is influenced minimally by the presence of an observer.

The honeyeater formerly was common in nearly all habitats on Guam and was particularly abundant around village gardens, where flowering plants provided an ample source of nectar. It is now restricted to limited areas on northern Guam, where Jenkins (1983) reported it to be most common in second-growth and mixed forests of the Northwest Field Region. During this survey, the highest densities were found in the relatively undisturbed forests

Table 6. Forest bird population size estimates for each region.

Region	Bridled White-eye	Guam Broadbill	Rufous-fronted Fantail	Cardinal Honeyeater	Mariana Fruit-Dove	White-throated Ground-Dove	Mariana Crow	Micronesian Kingfisher	Micronesian Starling	Totals
Pajon Basin	1,510	89	460	274	20	15	5	163	1,608	4,144
Ritidian Basin	179	93	136	124	26	57	4	58	798	1,475
Uruno Basin	26	87	9	14	9	38	12	129	960	1,284
Tarague Basin	31	42	*	207	13	7	29	261	1,305	1,895
Pati Basin		18	1	17		6	6	41	287	376
Pajon Plateau	474	83	164	553	36	*	30	244	1,143	2,727
Northwest Field		15	231	1,236	122	229	61	514	3,808	6,216
Magazine		33	47	236	15	20	53	505	2,988	3,897
Tarague Plateau						*	93	586	3,075	3,754
Andersen AFB						119	25	164	231	539
Central Plateau								280	105	385
Mt. Santa Rosa							32		104	136
Haputo Point				21		57	7	78	364	527
Dos Amantes										
Andersen South										
Cocos Island									198	198
Total	2,220	460	1,048	2,682	241	548	357	3,023	16,974	27,553

* Species not recorded in these regions during 8-min counts, but recorded as incidental sighting or otherwise presumed to be present.

Table 7. Confidence limits (95%) for total population size estimates. The interval does not take into account the uncertainty in estimating effective areas. Estimates for the Guam Rail, Black Drongo, and Philippine Turtle-Dove represent only a portion of the total population, since only part of their range on Guam was surveyed (see species accounts). The estimates for the Mariana Crow and Guam Rail are based on special survey methods (see methods section), and no confidence intervals are given.

Species	Population estimate	Confidence interval	
		Low	High
Mariana Fruit-Dove	241	210	275
Mariana Crow	357	-	-
Guam Broadbill	460	250	840
White-throated Ground-Dove	548	310	970
Rufous-fronted Fantail	1,048	860	1,290
Bridled White-eye	2,220	1,750	2,800
Guam Rail	2,329	-	-
Cardinal Honeyeater	2,682	2,300	3,140
Black Drongo	2,882	2,350	3,520
Micronesian Kingfisher	3,023	2,460	3,640
Philippine Turtle-Dove	5,458	4,060	7,440
Micronesian Starling	16,974	15,330	18,800

Table 8. Bridled White-eye species summary.

Region	Number of birds detected	Effective area surveyed (km²)	Bird density (birds per km²)	Available habitat (km²)	% of available habitat surveyed	Estimate of population size
Pati Basin		0.23		1.54	15	
Andersen AFB		0.05		4.24	1	
Tarague Basin	5	0.14	14	2.23	6	31
Tarague Plateau		0.04		10.30	0	
Magazine		0.10		6.63	2	
Pajon Basin	107	0.07	1,027	1.47	4	1,510
Pajon Plateau	30	0.15	125	3.78	4	474
Ritidian Basin	19	0.05	197	0.91	6	179
Northwest Field		0.53		15.22	3	
Uruno Basin	3	0.13	14	1.84	7	26
Haputo Point		0.05		7.13	0	
Central Plateau		0.18		21.67	1	
Mt. Santa Rosa		0.05		15.90	0	
Dos Amantes		0.02		5.92	0	
Andersen South		0.04		2.89	1	
Cocos Island		0.06		0.27	21	
Total	164	1.90	217[a]	101.94	1.86	2,220

[a] The total bird density on this and following tables is the average density in all regions where the species was present (total estimate/available habitat in occupied regions).

of the extreme northwest tip of Guam (Table 9). Densities dropped off dramatically in adjoining regions. Our population size estimate for the honeyeater is 2,682.

Guam Broadbill, *Myiagra freycineti*. The species is endemic to Guam.

This insectivorous species is now among the most diminished of all native forest birds. Like other members of this genus in Micronesia, pairs aggressively defend territories against other birds, and approach and scold human intruders as well. The species forages within the forest, and individuals are rarely seen outside protective vegetation. The call is a loud series of whistles which is given fairly commonly during morning hours.

The broadbill survives in very low densities, and only in extreme northwest Guam can the species be encountered regularly (Table 10). Only 43 were recorded during the survey, the lowest number recorded for any forest bird except the Guam Rail and Vanikoro Swiftlet. Our population size estimate is 460.

Guam Rail, *Rallus owstoni*. The species is endemic to Guam.

Jenkins (1979) reviewed the life history of the Guam Rail based on his field observations and on roadside counts and field notes of GAWRD biologists from 1960 to 1978. The rail is a secretive, flightless, territorial species that is most easily observed as it bathes or feeds along roadsides or field edges. The call is a loud, piercing whistle or series of whistles (Kibler 1950), usually given by two or more birds in response to a loud noise, the call of another rail, or other disturbances. Though individuals will respond almost invariably to the call of another rail, the species is generally silent.

Before the 1970's, the rail occurred island-wide, but it is now rare and restricted to the northern half of Guam (Figure 4). The population declined severely from 1969-73, and the rail disappeared from southern Guam in the mid 1970's (Jenkins 1979). It still maintains a wider distribution than most other forest birds, and since 1979 rails have been recorded from every region of northern Guam except Uruno Basin (Table 11). It is probable that a few are present in Uruno Basin as well, since they are found in the three adjoining regions in similar habitat. We included in Table 11 results from a station that GAWRD established near Tolang. No rails were recorded here, and we believe this station was just outside the southern extreme of the rail's present distribution.

The rail is one of the few native birds that is found more frequently in scrubby second growth or mixed forest than in uniform tracts of mature forest, and might have been more abundant after the arrival of man than before. The Andersen South Region, where high densities were recently found, is greatly disturbed, being composed of 51.7% agriforest, 33.3% scrub forest, 8.7% urban, and 6.5% broken forest. Distribution remains an anomaly, though, as other regions with similar habitat composition have few rails.

Table 9. Cardinal Honeyeater species summary. The three birds from Haputo Point were recorded during 1981 GAWRD counts.

Region	Number of birds detected	Effective area surveyed (km²)	Bird density (birds per km²)	Available habitat (km²)	% of available habitat surveyed	Estimate of population size
Pati Basin	12	0.48	11	1.54	31	17
Andersen AFB		0.10		4.24	2	
Tarague Basin	37	0.29	49	4.21	7	207
Tarague Plateau		0.09		10.30	1	
Magazine	14	0.22	36	6.63	3	236
Pajon Basin	35	0.14	160	1.71	8	274
Pajon Plateau	77	0.32	146	3.78	8	553
Ritidian Basin	21	0.11	113	1.10	10	124
Northwest Field	149	1.11	81	15.22	7	1,236
Uruno Basin	3	0.27	7	2.01	13	14
Haputo Point	3	0.11	3	7.13	2	21
Central Plateau		0.38		21.67	2	
Mt. Santa Rosa		0.11		15.90	1	
Dos Amantes		0.05		5.92	1	
Andersen South		0.08		2.89	3	
Cocos Island		0.12		0.27	44	
Total	351	3.98	62	104.52	3.81	2,682

Table 10. Guam Broadbill species summary.

Region	Number of birds detected	Effective area surveyed (km²)	Bird density (birds per km²)	Available habitat (km²)	% of available habitat surveyed	Estimate of population size
Pati Basin	6	0.25	12	1.54	16	18
Andersen AFB		0.05		4.24	1	
Tarague Basin	4	0.15	10	4.21	4	42
Tarague Plateau		0.05		10.30	0	
Magazine	1	0.11	5	6.63	2	33
Pajon Basin	6	0.07	52	1.71	4	89
Pajon Plateau	6	0.17	22	3.78	4	83
Ritidian Basin	9	0.06	84	1.10	5	93
Northwest Field	1	0.59	1	15.22	4	15
Uruno Basin	10	0.14	43	2.01	7	87
Haputo Point		0.06		7.13	1	
Central Plateau		0.20		21.67	1	
Mt. Santa Rosa		0.06		15.90	0	
Dos Amantes		0.03		5.92	0	
Andersen South		0.04		2.89	1	
Cocos Island		0.06		0.27	23	
Total	43	2.09	13	104.52	2.00	460

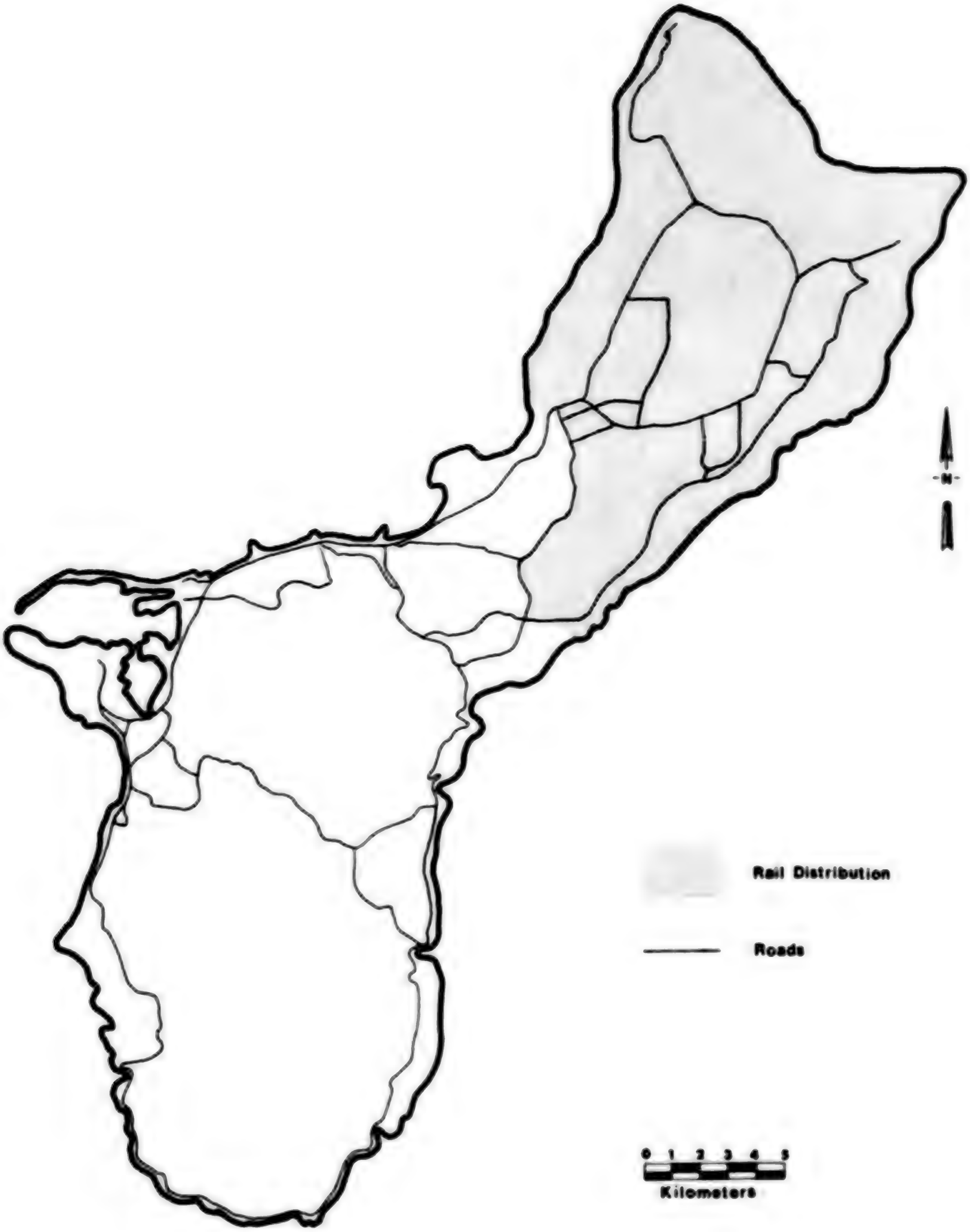

Figure 4. Approximate 1981 distribution of the Guam Rail, based on surveys by the GAWRD.

Table 11. Occurrence of Guam Rail based on 8-min counts during this survey, GAWRD 15-min counts, and playback recordings.

	This survey, 8-min counts		June and July 1981 playback recording		GAWRD counts[a] Jan. 1979 to Sept. 1981		Combined 8-min counts and playback recordings	
	counts	rails	counts	rails	counts	rails	counts	rails
Pati Basin[b]	29	0	0	-	0	-	29	0
Andersen AFB	12	0	6	0	63	6	81	6
Tarague Basin	50	0	23	4	65	1	138	5
Tarague Plateau	8	1	0	-	19	0	27	1
Magazine	30	1	14	2	0	-	44	3
Pajon Basin	24	0	7	1	0	-	31	1
Pajon Plateau	42	0	18	6	9	0	69	6
Ritidian Basin	29	1	11	3	68	4	108	8
Northwest Field	93	0	54	6	96	0	243	6
Uruno Basin	30	0	15	0	67	0	112	0
Haputo Point	0	-	0	-	73	1	73	1
Central Plateau	19	0	20	10	0	-	39	10
Mt. Santa Rosa	14	0	12	6	126	10	152	16
Dos Amantes	3	0	0	-	51	1	54	1
Andersen South	1	1	0	-	62	94	63	95
Tolang	0	-	0	-	41	0	41	0
Total	384	4	180	38	740	117	1,304	159

[a] Counts were 15 minutes long; thus for comparative purposes, data were taken only from the first 8 minutes of the count.

[b] One rail was recorded in Pati Basin on the June 1981 survey as an incidental sighting.

We venture no estimate of population on the basis of the 8-min count data, because out of 384 8-min counts in northern Guam, only three individuals were recorded. Playback counts with a cassette player were made at 148 of the 178 stations established in northern Guam (Table 12), and 38 rails were recorded on 180 counts (0.211/count). This was 20 times as many rails per count as on the standard 8-min counts. Rails within the vicinity of a playback count station would generally respond while the recording was still being played, or immediately after it was turned off. Rails were attracted to the source of the call, and would sometimes move to within 2 m of the observer before responding. When close, disturbed rails would occasionally utter a peculiar series of quiet grunts, totally unlike their normal call. The farthest distance estimate for which a rail responded was 80 m over an open field. Frequently two birds would respond on stations where rails were recorded.

The rate of response to the recording is not known, though superficially it appears that a very high percentage of rails answer. In at least one instance a rail that was heard just prior to the count did not respond to the tape. We noted that once a rail calls, it is frequently difficult to elicit a second response. It is probable that rails nearer the observer respond more readily than those that are farther away. At least twice rails did not respond within the first minute after the tape was played, but responded only after the tape was played a second time. These individuals possibly moved toward the observer upon first hearing the tape, and then, when they were much closer, answered the tape when it was played a second time. A good strategy for eliciting a response may be to play the tape once, wait one minute for a response, and then repeat the procedure.

Although we have limited information about the percentage of rails responding to the tape or about the effective detection area, we made a preliminary minimum population size estimate based on our playback data (Table 12). We assumed a 70-m detection distance, and that all rails within this distance of the played tape responded and were recorded. The estimate of 2,329 is likely an underestimate, since not all regions with rails were surveyed, and we assumed a rather large detection distance.

The decline of rails is still ongoing, as evidenced by recent counts by the GAWRD in the Andersen South Region. (This was one of the last strongholds of the rail; on counts from January 1979 to September 1981, 81% of all rails recorded were in the Andersen South Region, even though only 8% of the counts were made here.) In 1979 there were 70 rails recorded in 37 counts (1.89/count); in 1980 there were 10 rails in 10 counts (1/count); and in 1981 there were 14 rails in 16 counts (0.88/count). Preliminary data from 1982 indicate a continuing reduction in the numer of rails per count in this region.

Mariana Crow, Corvus kubaryi. The species is endemic to Guam and Rota.

The Mariana Crow is a gregarious species that frequently flies above the forest canopy, calling regularly. The crow is omnivorous, and forages quietly in the forest from the ground to the upper canopy. It is unusually tame, possibly a behavioral trait that evolved after long isolation from large predators, and will allow an observer to approach to within a few meters before

Table 12. Guam Rail species summary. Population size estimate is based on playback recording survey method. We assumed that all birds within 70 m of the observer (an area of 1.5 ha) responded to the played tape. Not all regions were surveyed, and the population is probably underestimated.

Region	Playback counts	Rails recorded	Effective area surveyed (km^2)	Density (rails/ km^2)	Available habitat (km^2)	Estimate of population size
Pati Basin	0	-	-	-	1.54	-
Andersen AFB	6	0	0.09	0	4.85	0
Tarague Basin	23	4	0.35	11.3	4.31	49
Tarague Plateau	0	-	-	-	10.30	-
Magazine	14	2	0.215	9.3	6.33	59
Pajon Basin	7	1	0.11	9.3	1.71	16
Pajon Plateau	18	6	0.28	21.7	3.78	82
Ritidian Basin	11	3	0.17	17.8	1.22	22
Northwest Field	54	6	0.83	7.2	15.22	110
Uruno Basin	15	0	0.23	0	2.01	0
Haputo Point	0	-	-	-	9.64	-
Central Plateau	20	10	0.31	33.3	38.06	1,267
Mt. Santa Rosa	12	6	0.185	32.4	22.35	724
Dos Amantes	0	-	-	-	11.22	-
Andersen South	0	-	-	-	6.64	-
Total	180	38	2.77	13.7	139.18	2,329

moving away. The call of the Mariana Crow is similar to the call of the American Crow of North America, *Corvus brachyrhynchos*, except that it is slightly higher in pitch. A crow's call carries great distances, especially on a calm quiet day when a bird is flying high above the forest.

Next to the Micronesian Starling, more crows were recorded (869) during the survey than any other species. Of these, 90% were heard but not seen. Twenty-eight percent were recorded as being 300 m or farther from the observer. Because we made no distance estimates to birds over 300 m away, we did not analyze crow data with the same statistical program used for the other forest birds. Instead, we used a relatively simple approach by first determining the average density ($6.074/km^2$) in three regions by a total count (Table 13). This average was then compared to the number of crows per 8-min count in these regions (2.631), and a conversion factor of 2.309 was determined which could be applied to data from 8-min counts from other regions.

Table 13. Density of Mariana Crow in three regions of northern Guam as determined by total counts.

Region	Forested area surveyed (km^2)	Crows recorded	Crows/ km^2
Tarague Basin	4.21	25	5.94
Ritidian Basin	1.10	6	5.45
Uruno Basin	1.44	10	6.94
Total	6.75	41	6.074

When total counts were made, most crows within each region were located within the first half hour of observation, and we feel that within 1.5 - 2 hours all or most crows within the survey area were identified. Tape recorded calls of the crow played at the end of the count period at Ritidian and Tarague Basins revealed no uncounted crows. There was considerable movement of crows within each region, as well as movement into and out of the survey area during the count. Individuals that spent most of the time outside the survey area were not included in the total. A few crows in areas distant from the observer (e.g., up to 3 km away in Tarague Basin) might have been overlooked. While conducting total counts, maximum and minimum estimates of the number of crows in each region were made. These estimates for the three surveyed regions averaged ±9% of the actual number estimated.

By multiplying the conversion factor by the number of crows per 8-min count, densities and population sizes were calculated for each region (Table 14). In light of the limited time spent on the total counts, these estimates should be viewed with caution. Confidence in these estimates could be improved by repeating total counts several times, stationing more than one observer around each basin when making the counts, or by simultaneously conducting 8-min counts and total counts within each basin.

Table 14. Mariana Crow species summary. The number of birds detected per 8-min count was multiplied by the conversion factor (2.309) to determine density. The eight birds recorded from Haputo Point and 20 birds from Mt. Santa Rosa are from 1981 GAWRD surveys.

Region	Number of birds detected	Number of 8-min counts	Bird density (birds per km²)	Available habitat (km²)	Estimate of population size
Pati Basin	51	29	4	1.54	6
Andersen AFB	31	12	6	4.24	25
Tarague Basin	161	50	7	4.21	29
Tarague Plateau	32	8	9	10.30	93
Magazine	99	30	8	6.63	53
Pajon Basin	32	24	3	1.71	5
Pajon Plateau	148	41	8	3.78	30
Ritidian Basin	38	23	4	1.10	4
Northwest Field	172	91	4	15.22	61
Uruno Basin	72	30	6	2.01	12
Haputo Point	8	24	1	7.13	7
Central Plateau		19		21.67	
Mt. Santa Rosa	53	67	2	15.90	32
Dos Amantes		3		5.92	
Andersen South		16		2.89	
Cocos Island		18		0.27	
Total	897	485	5	104.52	357

Results from 1978-81 GAWRD counts indicate a slight upward trend in crow numbers and our June 1981 survey revealed a higher number of crows per count than 1978-81 GAWRD counts (Table 15). Pratt et al. (1979), also stated that the crow had possibly increased in numbers from 1976 to 1978. Though the crow appears to be maintaining itself in low numbers on northern Guam, it presently occupies only a fourth of its 1950's range.

Table 15. Number of Mariana Crows recorded from 1978-81, GAWRD 8-min counts, station numbers 3-15 (Additional stations were established by GAWRD in 1980, but data from these new stations were deleted in this table for comparative purposes among years). During this survey we recorded 869 crows in 324 8-min counts, or 2.3/count.

Year	Crows	Counts	Crows/Count
1978	56	97	0.577
1979	224	334	0.671
1980	76	89	0.854
1981	83	71	1.169

Mariana Fruit-Dove, Ptilinopus roseicapilla. The species is endemic to the Marianas.

This is a secretive species that feeds in the upper canopy, its green plumage blending with the surrounding foliage. The call, a loud and penetrating series of coos, is given often, but at irregular intervals, and periods of active calling are generally followed by quiet interludes. The bird's presence is indicated almost exclusively by the call, and as this is heard frequently in northern Guam, a casual observer might expect densities to be relatively high. The call carries well, however, and is a misleading index of the species abundance.

The fruit-dove was the fifth most commonly recorded native species with 259 being recorded during the 8-min counts (Table 16). The fruit-dove was the only native forest bird that was recorded strictly on the basis of its call; none of the 259 birds detected was seen. Four of the birds recorded (1.5%), were 300 m or farther from the observer. Despite the relatively high number recorded, it is one of the rarest forest birds on Guam, with a population size estimate of only 241. On Guam, the dove is found in the northwest regions where native forest is the most common habitat. However, numerous birds are

Table 16. Mariana Fruit-dove species summary.

Region	Number of birds detected	Effective area surveyed (km^2)	Bird density (birds per km^2)	Available habitat (km^2)	% of available habitat surveyed	Estimate of population size
Pati Basin		1.54		1.54	100	
Andersen AFB		0.75		4.24	18	
Tarague Basin	32	2.11	6	2.23	95	13
Tarague Plateau		0.65		10.30	6	
Magazine	7	1.57	2	6.63	24	15
Pajon Basin	21	1.00	13	1.47	68	20
Pajon Plateau	35	2.30	9	3.78	61	36
Ritidian Basin	40	0.82	29	0.91	91	26
Northwest Field	109	8.07	8	15.22	53	122
Uruno Basin	15	1.84	5	1.84	100	9
Haputo Point		0.61		7.13	9	
Central Plateau		2.75		21.67	13	
Mt. Santa Rosa		0.78		15.90	5	
Dos Amantes		0.34		5.92	6	
Andersen South		0.41		2.89	14	
Cocos Island		0.27		0.27	100	
Total	259	25.81	8	101.94	25.32	241

also present in the Northwest Field Region, where the cover is composed of about equal proportions of scrub forest and primary limestone forest.

Micronesian Kingfisher, Halcyon c. cinnamomina. The species is found in Palau and Ponape of the Caroline Islands. The subspecies is endemic to Guam.

The kingfisher on Guam is a forest resident and is not typically associated with water habitats. It forages by pouncing from an overhead perch upon insects, lizards, and other small animals. The nest is placed in the cavity of a tree, which is generally hollowed out by the kingfisher. The call is loud and rasping. The kingfisher perches motionless for long periods and, unless a call is given, can be difficult to locate. On occasion the kingfisher will perch on telephone wires and is easily seen. Calls, which are voiced regularly, carry considerable distances. Six of the 484 birds recorded (1.2%) were 300 m or farther from the observer.

The kingfisher remains one of the most widely distributed of all native species (Table 17), and presently occupies about 40% of its 1950's range. Throughout much of this area, densities are low. The total population size estimate is 3,022. The kingfisher is one of the few species that can still be found in the agriforest of the Central Plateau Region.

Micronesian Starling, Aplonis opaca guami. The species is known from all major islands of the Carolines. The subspecies is restricted to the Mariana Islands.

The starling regularly forms small, noisy groups that move actively through the forest. The call is a loud whistle-like note, or series of such notes, that carries a considerable distance. Though curious and attracted to an observer, the starling is wary and generally remains within the upper forest canopy as it approaches an observer. The starling is omnivorous and consumes a variety of fruit and other vegetable or animal matter.

The starling retains one of the most widespread distributions of any of the native forest birds, and occupies about 37% of its 1950's range. Throughout most of the southern portion of this range (the Central Plateau and Mt. Santa Rosa regions), densities are much lower than densities in far northern Guam. The starling can occasionally be found outside the distribution determined from this survey. At least two small populations exist outside northern Guam, one on Cocos Island and the other in downtown Agana. The density of the remnant population on Cocos Island is as high as in regions of northern Guam (Table 18). The small population in Agana was not surveyed. The species is relatively tolerant of human activities, and formerly was found in agriforest and urban settings; today it can be found in limited numbers in these habitats on northern Guam.

A total of 1,787 starlings was recorded during the survey, more individuals than any other species. The starling is the most numerous forest species on Guam, and we estimated the population size to be 16,974.

Table 17. Micronesian Kingfisher species summary. The 18 birds from Haputo Point were recorded during 1981 GAWRD counts.

Region	Number of birds detected	Effective area surveyed (km^2)	Bird density (birds per km^2)	Available habitat (km^2)	% of available habitat surveyed	Estimate of population size
Pati Basin	43	0.83	27	1.54	54	41
Andersen AFB	11	0.18	39	4.24	4	164
Tarague Basin	81	0.51	62	4.21	12	261
Tarague Plateau	14	0.16	57	10.30	2	586
Magazine	53	0.38	76	6.63	6	505
Pajon Basin	36	0.24	95	1.71	14	163
Pajon Plateau	58	0.55	66	3.78	15	244
Ritidian Basin	16	0.20	53	1.10	18	58
Northwest Field	110	1.93	34	15.22	13	514
Uruno Basin	49	0.46	64	2.01	23	129
Haputo Point	18	0.20	11	7.13	3	78
Central Plateau	13	0.66	13	21.67	3	280
Mt. Santa Rosa		0.19		15.90	1	
Dos Amantes		0.08		5.92	1	
Andersen South		0.13		2.89	5	
Cocos Island		0.21		0.27	76	
Total	502	6.91	38	104.52	6.61	3,023

Table 18. Micronesian Starling species summary. The 39 birds from Haputo Point were recorded during 1981 GAWRD counts.

Region	Number of birds detected	Effective area surveyed (km²)	Bird density (birds per km²)	Available habitat (km²)	% of available habitat surveyed	Estimate of population size
Pati Basin	154	0.43	186	1.54	28	287
Andersen AFB	8	0.09	55	4.24	2	231
Tarague Basin	209	0.26	310	4.21	6	1,305
Tarague Plateau	38	0.08	299	10.30	1	3,075
Magazine	167	0.19	451	6.63	3	2,988
Pajon Basin	184	0.12	838	1.71	7	1,608
Pajon Plateau	141	0.28	302	3.78	8	1,143
Ritidian Basin	124	0.10	725	1.10	9	798
Northwest Field	418	1.00	233	15.22	7	3,808
Uruno Basin	188	0.24	472	2.01	12	960
Haputo Point	39	0.09	51	7.13	1	364
Central Plateau	3	0.34	5	21.67	2	105
Mt. Santa Rosa	1	0.10	7	15.90	1	104
Dos Amantes		0.04		5.92	1	
Andersen South		0.06		2.89	2	
Cocos Island	152	0.11	734	0.27	39	198
Total	1,826	3.54	178	104.52	3.39	16,974

Rufous-fronted Fantail, Rhipidura rufifrons uraniae. The species is found in the Carolines, the Marianas, and the Solomons. The subspecies is endemic to Guam.

This active flycatcher is a conspicuous resident of the forest understory, and its melodious song can be regularly heard in northwest Guam. Overall, the fantail is readily surveyed; it is a nonflocking species that defends a territory, sings frequently throughout the morning, and has a medium-volume song. However, the fantail will sometimes approach an observer to scold.

One hundred ninety-nine birds were recorded during the survey, and the population size is estimated to be 1,050. The fantail is restricted to forested habitats of northwest Guam, mostly in the Ritidian and Pajon Basin regions.

Vanikoro Swiftlet, Aerodramus vanikorensis bartschi. The species is widespread from the Philippines to New Guinea and Australia, and in Micronesia is found on Palau and the Marianas. The subspecies is endemic to the Marianas.

The swiftlet nests and roosts in caves and is airborne throughout most of the day. It forages above a variety of habitats, but shows a preference for forest openings, particularly near ponds and streams. Although mostly silent, the swiftlet is capable of low volume calls consisting of harsh twittering and other clicking noises. The species is highly mobile and is capable of traveling considerable distances within a short time, but movement patterns are poorly understood.

Only 18 individuals were recorded on this survey, all during one, 8-min count in the Talofofo Watershed in southern Guam. These 18 birds comprised a single group, one of the largest recently seen. At one time, the swiftlet was abundant and ubiquitous on Guam, but is now nearly extinct. Apparently only one or two small colonies in southern Guam remain, with individuals and small groups regularly sighted near the Talofofo Watershed (Jenkins 1983). Most sightings in this area are of only a few birds, and the total population size on Guam is almost certainly under 100.

In 1979, Jenkins (1983) sighted a group of 14 swiftlets in the Ritidian Region of northern Guam, and there have been several other sightings in northern Guam since. Jenkins suggested that a small colony might still occur along the northern cliffs, but after a month of intensive field work on this survey in the northern half of Guam, no birds were recorded. We doubt if any viable colonies still exist in the North. The sighting by Jenkins on northern Guam followed a tropical storm, and possibly the flock was a stray group of birds from Agiguan, Saipan, or southern Guam. The swiftlet is one of the few native species which maintains a remnant population on the southern rather than northern portion of Guam.

White-throated Ground-Dove, Gallicolumba x. xanthonura. The species is found on Ponape, Truk, Yap, and the Mariana islands. The subspecies is restricted to Yap and the Marianas.

Table 19. Rufous-fronted Fantail species summary.

Region	Number of birds detected	Effective area surveyed (km^2)	Bird density (birds per km^2)	Available habitat (km^2)	% of available habitat surveyed	Estimate of population size
Pati Basin	1	0.70	1	1.54	46	1
Andersen AFB		0.15		4.24	4	
Tarague Basin		0.43		4.21	10	
Tarague Plateau		0.13		10.30	1	
Magazine	4	0.32	7	6.63	5	47
Pajon Basin	86	0.20	269	1.71	12	460
Pajon Plateau	34	0.46	44	3.78	12	164
Ritidian Basin	34	0.17	124	1.10	15	136
Northwest Field	37	1.63	15	15.22	11	231
Uruno Basin	3	0.39	5	2.01	19	9
Haputo Point		0.17		7.13	2	
Central Plateau		0.55		21.67	3	
Mt. Santa Rosa		0.16		15.90	1	
Dos Amantes		0.07		5.92	1	
Andersen South		0.11		2.89	4	
Cocos Island		0.17		0.27	64	
Total	199	5.82	33	104.52	5.56	1,048

On Guam, the name for this dove is somewhat of a misnomer, as it is a species that nests and forages in trees. The male is seen more often than the female, apparently because of its less secretive behavior (Jenkins 1983). The ground-dove is secretive and inconspicuous when in foliage, but individuals occasionally flying above the forest canopy are easily seen. The call is a soft, low coo, given infrequently.

The ground-dove is relatively widespread on Guam, but occurs in very low densities. Only 62 birds were recorded during the survey. Our total population estimate of 548 (Table 20) shows the species as one of the rarest on Guam. No ground-doves were recorded on Tarague Plateau or Pajon Plateau, but the species probably occurs in both regions. Like the Micronesian Starling, the ground-dove can sometimes be seen outside the distribution determined by this survey. We suspect that these are nonbreeding individuals.

Nonforest and Introduced Birds

Though we confined ourselves primarily to forested habitats where native forest species are found, limited numbers of nonforest and introduced birds were recorded during 8-min counts. These include seabirds, waterbirds, and introduced species. Because populations for these species were only partially sampled and only low numbers were recorded for most, densities were not estimated. We did, however, calculate partial estimates for the Black Drongo and Philippine Turtle-Dove, which commonly utilize forest openings and edges. Most of these species appear not to have undergone the dramatic declines suffered by native forest birds.

Guam has seven introduced species, more than any other Micronesian island, and all are well-established. All introduced species were recorded during the survey. None can be considered as a true forest bird, with the exception of the Red Junglefowl.

Seabirds and Waterbirds

Common Moorhen, _Gallinula chloropus guami_. The species is distributed nearly worldwide. The subspecies is endemic to the Mariana Islands.

This is a rare species on Guam and can be found regularly only near large bodies of standing water. The loss of wetland habitat has apparently restricted distribution and abundance of the gallinule. Two birds were recorded on the survey, both on a count in the Talofofo Watershed of southern Guam.

Brown Noddy, _Anous stolidus pileatus_. The species is found throughout tropical and subtropical oceans. The subspecies ranges from the mid-Pacific to the Indian Ocean.

This is a fairly common seabird of Guam. It roosts and nests in colonies on coastal islets, and there are a few small colonies in large trees on northern Guam. Seven individuals were recorded at scattered locations in northern Guam.

Table 20. White-throated Ground-dove species summary. The six birds recorded from Haputo Point are from 1981 GAWRD counts.

Region	Number of birds detected	Effective area surveyed (km²)	Bird density (birds per km²)	Available habitat (km²)	% of available habitat surveyed	Estimate of population size
Pati Basin	3	0.42	4	1.54	27	6
Andersen AFB	4	0.09	28	4.24	2	119
Tarague Basin	2	0.25	3	2.23	11	7
Tarague Plateau		0.08		10.30	1	
Magazine	1	0.19	3	6.63	3	20
Pajon Basin	2	0.12	11	1.47	8	15
Pajon Plateau		0.28		3.78	7	
Ritidian Basin	11	0.10	62	0.91	11	57
Northwest Field	25	0.97	15	15.22	6	229
Uruno Basin	8	0.23	21	1.84	13	38
Haputo Point	6	0.10	8	7.13	1	57
Central Plateau		0.33		21.67	2	
Mt. Santa Rosa		0.09		15.90	1	
Dos Amantes		0.04		5.92	1	
Andersen South		0.07		1.89	2	
Cocos Island		0.10		0.27	38	
Total	62	3.46	13	101.94	3.39	548

Pacific Reef Heron, Egretta s. sacra. The species and subspecies is widespread in the central and western Pacific.

The reef heron is a common coastal resident and is occasionally seen flying above the forest, particularly in coastal areas. Ten birds were recorded during the 8-min counts, all in northern Guam. The species is capable of hoarse croaks, but all individuals recorded were seen, not heard. Several individuals were seen on Cocos Island, but were not recorded during the 8-min counts.

White Tern, Gygis alba candida. The species is widespread in tropical oceans. The subspecies is found in the western Pacific.

The White Tern is a common seabird on Guam. A thriving colony roosts and nests on Cocos Island. Smaller groups can be found inland. Of the 192 individuals recorded during 8-min counts, 145 were recorded from Cocos Island, and the remainder were sighted in northern Guam.

Yellow Bittern, Ixobrychus sinensis. The species is widespread from Southeast Asia to New Guinea and Micronesia.

This small bittern is secretive and difficult to locate when perched in vegetation, but individuals are commonly seen as they fly above the vegetation canopy. The call, which is uttered infrequently, is a harsh two-note croak given in flight or while perched. Bitterns occupy a variety of habitats including freshwater streams and marshes, grassy fields, and thick, brushy upland vegetation. Though partial to wetlands, it also frequents dry habitats and commonly utilizes forest edges. It is rarely, if ever, found within the interior of uniform, well-developed forest.

The bittern is distributed throughout Guam, and is one of the only bird species that occupies all of its former range. In fact, the cutting and disruption of the original forests by man has probably increased the amount of habitat available to this species. Only 38 individuals were recorded during the survey, and no effective detection area or densities were estimated. Nearly all records for the bittern are in regions with disturbed habitats (Table 21), indicating the species' preference for such areas.

The bittern is a relatively nonvocal species, and in contrast to the forest birds of Guam, most bitterns recorded during the survey were seen rather than heard. Although only 5%-15% of most forest birds were detected visually, 63% of the bitterns were detected visually, indicating marked behavioral and/or ecological differences.

According to Jenkins (1983), there is evidence based on his observations and past reports (Marshall 1949, Baker 1951) that the current bittern population size on Guam has declined slightly from former estimates. If true, the decline may be caused by a reduction in the amount of wetlands or grassy and herbaceous openings created by World War II military operations. Today, many of these openings are filling in with dense, woody vegetation which is not preferred habitat for the bittern. The bittern may also be decreasing due

Table 21. Yellow Bitterns recorded during 8-min counts.

Region	Number heard	Number heard then seen	Number seen	Total
Tarague Plateau	1	2	5	8
Magazine			2	2
Pajon Plateau			1	1
Northwest Field	3			3
Central Plateau	1	1	11	13
Alamagosa Spring			1	1
Talofofo Watershed	3	2		5
Ylig Watershed		1		1
Cocos Island			4	4
Total	8	6	24	38

to the same as yet unknown limiting factor or factors that have decimated forest birds populations.

The bittern is one of the only native birds whose numbers and distribution have remained relatively stable over the last 20 years. The species is widespread outside of Guam and is possibly more adaptable than other native birds of Guam.

The bittern may be resistant to disease, or may somehow be able to avoid predation by the brown tree snake, Boiga irregularis. This may assist in explaining its relatively stable status. The study and understanding of the biological and ecological mechanisms that have allowed the bittern to persist may ultimately lead to the understanding of the present plight of Guam birds.

Introduced Birds

Black Drongo, Dicrurus macrocercus. The species is native to Taiwan.

The drongo is one of the most conspicuous birds on Guam and can commonly be seen perched on telephone wires or trees along roads and forest edges. The species is highly vocal, and frequently voices loud, unmusical calls. It was introduced to Rota by the Japanese in 1935 (Baker 1951), and spread from Rota to Guam, a distance of 50 km, either of its own accord or by human introduction. The drongo first appeared in northern Guam, apparently in the early 1960's (Tubb 1966; Wood 1968). The species forages primarily on large insects that are caught on the wing. The drongo is presently the subject of GAWRD studies which assess the species' role as a competitor with native species (A. Maben, pers. comm.).

In general, the species is common to abundant in northern and central Guam, and becomes increasingly scarce in the South. Moderate numbers can be found at Orote Point. During the survey, drongos were recorded in every region of northern Guam (Table 22), but none were recorded on stations in southern Guam. There is ample habitat in the South and there is no apparent reason for the drongo to be rare or missing from this area. The pattern of distribution suggests that drongos may be restricted in range and numbers by the same limiting factor(s) affecting native forest birds (see discussion).

Black Francolin, *Francolinus francolinus*. The species is native to Southern Asia.

The Black Francolin was introduced as a game bird in 1961, and has become established in the savannas of southern Guam. A survey of the francolin was conducted in 1980 by GAWRD, resulting in a total population estimate of approximately 4,800 birds. Numbers were deemed sufficiently large to harvest, and the first hunting season was held in December 1980 (Maben and Cruz 1980). We only sampled a few areas of typical francolin habitat and recorded 4 birds at Alamagosa Springs and 18 birds in the Talofofo Watershed.

Blue-breasted Quail, *Coturnix chinensis*. The species is native to Southeast Asia.

This species was introduced by the Spanish from the Philippines in 1894 (Seale 1901), and has become established in the grasslands of Guam, particularly in the southern savannas. Three were recorded in the Talofofo Watershed. Little is known about the status of this species.

Chestnut Mannikin, *Lonchura malacca*. The species is found from Southeast Asia to Indonesia and the Philippines.

The Chestnut Mannikin was first reported on Guam in 1960 (King 1962), but was probably introduced sometime during the 1950's. It is a flocking species with a weak voice and is commonly found in grasslands, along roadsides, or in other disturbed habitats. Numbers have apparently been severely reduced in recent years, and the species is now rare in southern Guam. However, it is still relatively common in the North. The species was recorded in five regions during the 8-min counts: Tarague Plateau, Magazine, Northwest Field, Haputo Point, and Central Plateau. These regions are all highly disturbed, indicating the species' preference for such areas. Of the 84 individuals recorded, 72 were in the Magazine and Northwest Field regions.

Table 22. Black Drongo species summary. Not all regions of the drongo's range were surveyed, and the population estimate represents only a portion of the total population. The 16 birds from Haputo Point and 21 from Andersen South were recorded during 1981 GAWRD surveys.

Region	Number of birds detected	Effective area surveyed (km²)	Bird density (birds per km²)	Available habitat (km²)	% of available habitat surveyed	Estimate of population size
Pati Basin	14	1.59	5	1.54	100	7
Andersen AFB	5	0.34	9	17.49	2	154
Tarague Basin	31	0.97	12	4.31	23	52
Tarague Plateau	33	0.30	70	10.52	3	736
Magazine	78	0.72	60	6.63	11	198
Pajon Basin	12	0.46	17	1.71	27	28
Pajon Plateau	30	1.05	18	3.78	28	67
Ritidian Basin	14	0.38	23	1.22	31	28
Northwest Field	230	3.70	39	16.27	23	635
Uruno Basin	33	0.89	23	2.01	44	45
Haputo Point	16	0.33	6	10.84	3	65
Central Plateau	10	1.26	5	43.59	3	218
Mt. Santa Rosa	12	0.36	22	23.81	2	524
Dos Amantes	1	0.16	3	12.50	1	38
Andersen South	21	0.22	12	7.27	3	87
Cocos Island		0.27		0.27	100	
Total	540	13.00	18	163.76	7.94	2,882

Eurasian Tree Sparrow, *Passer montanus*. The species is native to the Old World.

The tree sparrow was introduced to Guam from 1945-60 (King 1962), and it is now common in urban areas. During 8-min counts, 77 birds were recorded in the Magazine, Northwest Field, Central Plateau, Dos Amantes, and Cocos Island regions. These are all highly disturbed areas and are typical of habitats utilized by the tree sparrow.

Philippine Turtle-Dove, *Streptopelia bitorquata*. The species is native to the Philippines, Borneo, and islands between.

This species was introduced to Guam by the Spanish, perhaps as long as 200 years ago (Baker 1951). It is presently a common species around forest openings in northern Guam (and on Cocos Island), but is uncommon to rare in southern Guam. The species was recorded in nearly every region of northern Guam (Table 23). Turtle-doves are hunted during a one-month season along with Black Francolins (Anderson 1980), the only birds legally hunted on Guam.

Red Junglefowl, *Gallus gallus*. The species is native to Southeast Asia and Malaysia.

The junglefowl is a common domestic fowl, and was probably introduced by the aboriginal Chamorros. Numerous races have been introduced since Europeans first arrived. During the survey, junglefowl were commonly heard near farms and residential areas, but we were interested primarily in feral birds. Only one bird was recorded that we thought was feral, this in the Northwest Field Region. Baker (1951) also found no feral junglefowl on Guam in 1945. On other Micronesian Islands, the junglefowl is a common feral species on both volcanic and limestone substrates, and as yet there is no explanation for the absence of feral birds on Guam.

DISCUSSION

The variable circular plot methodology can be relied upon to remove from raw counts of species those detectability effects that are attributable to differences in observers' abilities and differences in density of vegetation surrounding the stations. Whether the method produces accurate measures of population density, however, depends upon how closely a species' behavior adheres to the method's assumptions. Behavioral patterns which do not meet the assumptions required for obtaining true estimates of density include the following. Highly mobile species such as the Vanikoro Swiftlet, Mariana Crow, Micronesian Starling, or Bridled White-eye have their population densities overestimated by the variable circular plot method (Scott and Ramsey 1981). The method may also be susceptible to error introduced by species which voice low frequency calls, making estimation of distance quite difficult (Scott et al. 1981). The two native doves of Guam are cases in point. The method overestimates the density of species which are curious and attracted to the observer (Guam Broadbill and Rufous-fronted Fantail), but underestimates the

Table 23. Philippine Turtle-Dove species summary. One bird was also recorded on Southern Guam in the Ylig Watershed. Not all regions of the turtle-dove's range were surveyed, and the population estimate represents only a portion of the total population. The four birds from Haputo Point and 15 birds from Andersen South were recorded during 1981 GAWRD surveys.

Region	Number of birds detected	Effective area surveyed (km²)	Bird density (birds per km²)	Available habitat (km²)	% of available habitat surveyed	Estimate of population size
Pati Basin	20	0.45	24	1.54	29	37
Andersen AFB	17	0.10	110	17.49	1	1,924
Tarague Basin	6	0.27	8	4.31	7	34
Tarague Plateau	9	0.08	67	10.52	1	705
Magazine	43	0.20	118	6.63	3	780
Pajon Basin		0.13		1.71	8	
Pajon Plateau	23	0.30	46	3.78	8	174
Ritidian Basin	15	0.11	85	1.22	9	104
Northwest Field	40	1.05	26	16.27	6	423
Uruno Basin	2	0.25	5	2.01	13	10
Haputo Point	4	0.11	5	10.84	1	54
Central Plateau	10	0.36	15	43.59	1	654
Mt. Santa Rosa		0.10		23.81	0	
Dos Amantes	2	0.04	25	12.50	0	313
Andersen South	15	0.07	26	7.27	1	189
Cocos Island	45	0.11	213	0.27	31	57
Total	251	3.73	33	163.76	2.28	5,458

density of those that avoid the observer by moving away or ceasing vocalization. Guam Rails are so nondetectable by this method that techniques such as roadside counts and playing taped calls must be used. The tendency of many species to occur in small flocks or groups will not bias estimates of density, but does render the estimates more variable (Pollock 1981). A summary of these behavioral patterns and the degrees which the target species exhibit them is given in Table 24. We emphasize, however, that the method does provide indices free from observer and habitat effects even in those cases where the assumptions are obviously violated.

We feel that the distribution of each species within the various regions as determined by the survey closely reflects the present situation in the field. Distribution is likely to remain similar throughout the year, since few Guam species, if any, migrate seasonally. Certain species are highly mobile, however, and on occasion native forest birds can be found outside the distribution concluded by this survey.

We also feel that there is relatively minor seasonal fluctuation in forest bird numbers on Guam. The nesting season is extended or year round for most forest birds (Jenkins 1983), although it may be somewhat seasonal for the swiftlet, kingfisher, bittern, and rail. Since most or all species maintain territories throughout the year, variation in seasonal activity is minimal. Little is known regarding dispersion in response to changes in local resources, sex and age ratios, or behavioral differences among individuals, ages, and sexes.

A reconstruction of past and present distributions (Table 25) illustrates the magnitude of the recent population crash. By the 1950's most species had lost about 40% of their original range to savannas and urban areas. The greatly reduced present distribution reflects the recent disappearance of forest birds throughout all of southern and much of northern Guam. The most severely depleted populations now survive in less than 10% of their original range (Table 25). The status of the native forest avifauna on Guam is obviously critical, and if the present trend continues, existence for several species is tenuous at best.

Studies to explain the decline of all native Guam forest birds are just beginning, but as yet no single cause has been implicated. It is reasonable to assume that the limiting factor(s) is of a general nature, since it has apparently simultaneously affected species with considerably divergent biological and ecological traits. A number of limiting factors have been suggested (Jenkins 1983), and major ones include:

1. Disease: One of the most plausible explanations for the disappearance of birds on Guam is disease, most likely avian malaria or avian pox. We found mosquitoes, possible disease vectors, to be abundant and widespread in the forests of Guam (including the caves where swiftlets once nested), but they are virtually absent from Cocos Island. Several of the introduced avian species may be acting as disease reservoirs.

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Table 24. Behavioral patterns influencing the ability of the variable circular plot method to estimate absolute population density.

Species	Visual conspicuousness	Flocking tendency	Mobility	Song	Response to observer	Subjective assessment of agreement
Black Drongo	High	Moderate	Moderate	Loud/regular	Minimal	Fair
Bridled White-eye	Fair	Flocks of 3-6	High	Soft/frequent	Minimal	Poor
Cardinal Honeyeater	Fair	None; occasional feeding concentrations	Moderate	Moderate/ frequent	Minimal	Good
Guam Broadbill	Fair	Usually male/ female pairs	Low	Loud/ irregular	Attracted	Fair
Guam Rail	Low	Usually male/ female pairs	Low	Loud/ infrequent	Avoids	N/A*
Mariana Crow	High	Strong	High	Loud/ frequent	Minimal	N/A*
Mariana Fruit-Dove	Low	None; occasional feeding concentrations	Low	Loud/ irregular (low frequency)	Avoids	Fair
Micronesian Kingfisher	Fair	None	Low	Loud/ irregular	Minimal	Fair
Micronesian Starling	High	Moderate	High	Loud/frequent	Slightly attracted	Poor
Philippine Turtle-Dove	Fair	Slight; occasional feeding concentration	Moderate	Moderate/ irregular (low frequency)	Minimal	Fair

(continued)

Table 24. (Concluded).

Species	Visual conspicuousness	Flocking tendency	Mobility	Song	Response to observer	Subjective assessment of agreement
Rufous-fronted Fantail	Fair	Usually male/ female pairs	Low	Moderate/ frequent	Attracted	Good
White-throated Ground-Dove	Fair	None	Moderate	Soft/ infrequent (low frequency)	Minimal	Fair
Vanikoro Swiftlet	High	Strong	High	Very soft/ frequent	Minimal	N/A*

* We felt assumptions were so poorly met for these species that population estimates were not made using this program.

Table 25. Changes in distribution of Guam forest birds through history. The area (km^2) originally inhabited by all species is the amount of forest before the arrival of the Chomorro settlers, nearly the entire island (500 km^2).

Species	Area of original distribution (km^2)	Distribution in 1950's		Present distribution		
		Area (km^2)	% of original range	Area (km^2)	% of 1950's range	% of original range
Bridled White-eye	500	309	62%	10	3%	2%
Cardinal Honeyeater	500	339	67%	64	19%	13%
Guam Broadbill	500	312	62%	43	14%	9%
Guam Rail	500	312	62%	162	52%	32%
Mariana Crow	500	312	62%	74	24%	15%
Mariana Fruit-Dove	500	309	62%	39	13%	8%
Micronesian Kingfisher	500	339	67%	132	39%	26%
Micronesian Starling	500	339	67%	124	37%	25%
Rufous-fronted Fantail	500	312	62%	42	13%	8%
Vanikoro Swiftlet	500	475	95%	?	trace	trace
White-throated Ground-Dove	500	309	62%	72	23%	14%
Yellow Bittern	500	500	100%	500	100%	100%

2. Introduced predators: The brown tree snake (also known as the Philippine rat snake), Boiga irregularis, is a potentially destructive predator, introduced about 1947. It is distributed over most of the island and forages both on the ground and in trees. The snake reaches a length of 2.5 m and is known to feed on birds and bird eggs. Other predators that may suppress populations of native birds include the monitor lizard (Varanus indicus), rats, feral cats, pigs, and dogs. Three species of introduced rats occur on Guam: the roof rat, Rattus rattus, Polynesian rat, R. exulans, and Norwegian rat, R. norvegicus. The roof rat and Polynesian rat are relatively common rodents. A large number of feral cats and dogs roam Guam, and are especially common near residential areas; a few birds such as the flightless Guam Rail may be adversely affected by these predators. Most predators, with the exception of the brown tree snake, are believed to have been on Guam long before the present decline in bird numbers began (Jenkins 1983).

3. Pesticides: DDT and other chlorinated hydrocarbons were used by the military from World War II to the mid 1970's, and may have depressed forest bird populations. A study to determine the levels of residual pesticides on Guam was undertaken in June 1981 by the USFWS Patuxent Wildlife Research Center and the GAWRD. Preliminary results indicate that the use of pesticides is not currently influencing the abundance and distribution of native birds (C. Grue, pers. comm.), though they might have in the past.

4. Habitat Loss: Over the last 40 years, many forested areas of Guam have been converted to open fields, roads, residential areas, and military installations. Though much of the development on Guam has been related to military activities, the continued existence of birds in northern Guam is a direct result of military presence there. Without the military, much of northern Guam would undoubtedly be privately developed for tourism or residential areas, particularly on such desirable beachfronts as in Tarague or Ritidian Basins.

   After World War II, large areas disturbed during the war were seeded with Leucaena glauca, a shrubby legume that forms dense, homogeneous stands on many areas of Guam. Though several native species such as the Rufous-fronted Fantail and Guam Broadbill reside in thickets of Leucaena, it provides only marginal habitat for frugivorous species such as the Mariana Fruit-Dove and White-throated Ground-Dove. Though much of Guam has been altered, relatively suitable native forests remain in southern and northern Guam that are devoid of nearly all bird life.

   In addition to human-induced alteration of forests, typhoons periodically destroy much of the vegetation on Guam. Typhoons, however, are not thought to have a major, lasting, negative impact on Guam bird densities (Jenkins 1983).

RECOMMENDATIONS

Positive actions will be needed before the decline of forest birds can be reversed. The first step is to implement studies that will explain the causes for the current low population numbers. Most logically, these studies should concentrate on disease and predation. Until clearly defined causes for the decline can be identified, efforts should be made to maintain forests in regions that harbor native birds. Any disturbance of the forest, besides directly removing habitat from native species, encourages the encroachment of introduced species that may be serving as disease reservoirs. Thus, new roads, housing, and other projects should be planned to minimize disturbance of forested tracts, and reforestation should be encouraged wherever feasible. The harvest of introduced ungulates (feral pig, *Sus scrofa*, and sambar deer, *Cervus unicolor*) should be continued, since at high densities these species may damage the forest understory.

Regions most valuable to forest birds are now well identified. The five regions in the extreme Northwest: Ritidian Basin, Pajon Basin, Tarague Basin, Uruno Basin, and Pajon Plateau, support ten species of native forest birds (all but the swiftlet). In the Northwest Field and Magazine regions, nine species reside (swiftlet and white-eye absent), and in Pati Basin, eight species can be found (swiflet, white-eye, and fruit-dove absent). In the remaining regions the number of resident species drops dramatically, and only five native species are found in Tarague Plateau, Andersen AFB, and Haputo Point; three in Central Plateau and Mt. Santa Rosa, and only one species in Dos Amantes and Andersen South regions. Certain regions are of high value even though they harbor few forest bird species. The Andersen South Region is valuable because of its relatively high density of rails, though there is evidence that the rail is now disappearing from this area. Cocos Island, a low, small, sandy islet, is important as a comparative study site for avian investigations, and special efforts should be made to minimize disturbances here. Though only one native forest bird, the Micronesian Starling, is found on Cocos Island today, there were probably never more than a few native forest birds here. Tourist resort development may ultimately alter much of the native forest on Cocos Island.

Initial steps for listing Guam forest birds on the U.S. Endangered Species List have been undertaken, and the Government of Guam in 1979 enacted its own endangered species act. In 1982, 12 native birds were listed as threatened or endangered and afforded protection under the Guam Act. These measures should help direct attention to the forest birds on Guam, and ultimately recovery plans may be developed for each species. Until such time, the most appropriate strategy is to accelerate investigative studies and to maintain the integrity of forest habitat in regions that still harbor native forest birds.

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A cooperative survey of the forest birds of Guam was conducted in 1981 by Division of Aquatic and Wildlife Resources, Territory of Guam, and the U.S. F and Wildlife Service. This survey represents the first systematic and compre effort to obtain baseline data on the distribution and abundance of Guam's avifauna. The results of the 1981 survey and historical records document the advanced state of decline in avian distribution, densities, and population sizes, and are used to identify the key remaining habitats for Guam's native birds. Possible causes of the decline such as disease, introduced predators, pesticides, and habitat loss, are discussed and recommendations for future studies are made.

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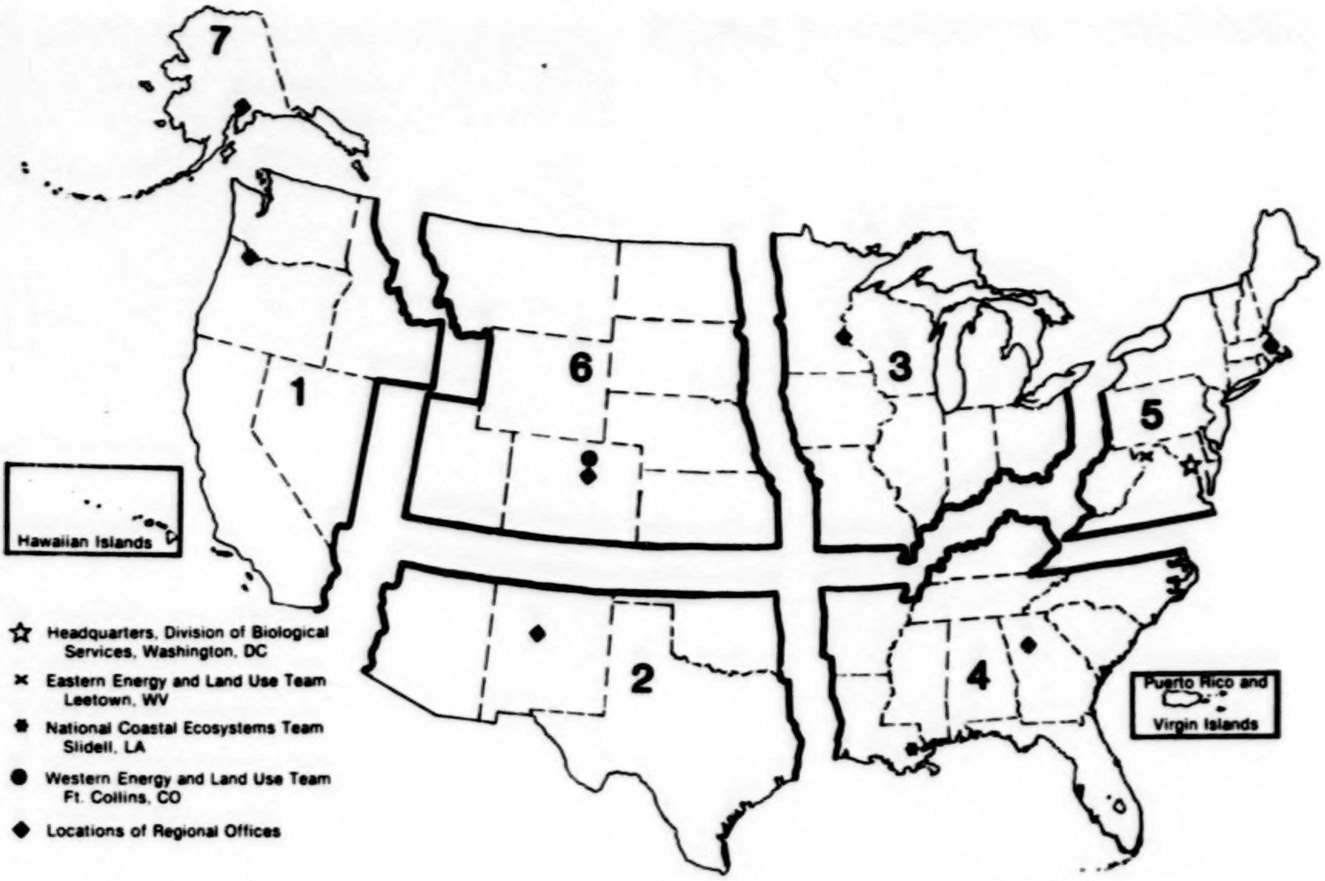
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57

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